ENGAGE
for ESG



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ENGAGE for ESG research results and policy recommendations

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1. Scope of the research

The analysis conducted by Ca' Foscari University (UNIVE) under the ENGAGE for ESG project relied on granular mortgage-level and collateral-level information sourced from European DataWarehouse GmbH (EDW), Europe's central repository for asset-backed security data under the ESMA Annex II template. The database contains detailed attributes of each loan—such as borrower income, loan-to-value ratio (LTV), interest rate, maturity, and payment status—together with the characteristics of the underlying property, including the EPC rating.

For this analysis, the sample was restricted to three major regional groups: France, the Netherlands, and a consolidated "rest of Europe" category that aggregates smaller markets (e.g., Belgium, Austria, Portugal, Finland, Ireland). These countries were chosen for their data completeness and representativeness of differing mortgage-market structures and EPC adoption maturity.

All records were harmonized at the loan level through a one-to-one merge between the Residential Real Estate Loan (RREL) and Residential Real Estate Collateral (RREC) templates, using the *Original Underlying Exposure Identifier* as the common key. Duplicate entries and inactive loans were removed, while missing EPC ratings were flagged but retained for reference.

As a result, UNIVE obtained an extensive dataset comprising over 14 million mortgage level observations after data cleaning and integration, corresponding to approximately 531,000 individual loans over the 2021–2025 period. As expected in mortgage datasets, the vast majority of loans are non-defaulting. Specifically, more than 98% observations correspond to non-defaulted loans, while only about 1.4% represent defaults. In this study, a loan was classified as defaulted if it failed to meet mortgage payment obligations for 90 consecutive days[1].

2. Research results

The analysis, documented in full in the project Deliverable D3.2 – *Technical report on risk mitigation correlation analysis* (December 2025), combined two complementary econometric approaches: a logistic regression model, which estimates the probability that a mortgage defaults, and a survival analysis (Kaplan–Meier estimator and Cox proportional hazards model), which estimates how quickly default occurs. Both approaches were applied to a balanced sample of defaulted and non-defaulted loans and control for borrower characteristics (income and employment status), loan characteristics (loan-to-value ratio, debt-to-income ratio, interest rate and interest rate type, original term and maturity) and property type, as well as for year and country fixed effects.

[1] In accordance with the definition provided in Article 178.1b) of Regulation (EU) No 575/2013.

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1.1 Descriptive analysis results

A clear inverse relationship between the energy performance of the collateral and credit risk is revealed.

Across the whole sample, **mortgages secured by A- and B-rated properties display default rates below 1% (0.91% and 0.89% respectively), whereas those secured by E- to G-rated dwellings show default rates between 2.2% and 2.5%.**

The same gradient is observed in each regional sub-sample:

- in France, A- and B-rated properties default at around 1% against 1.8%–2.0% for F- and G-rated properties;
- in the Netherlands, default rates remain below 1% across all energy classes;
- in the "rest of Europe" group, the least efficient classes reach default rates of 12%–14%. Furthermore, borrowers living in energy-efficient dwellings also display systematically stronger financial profiles—higher average income (approximately €71,000 against €56,000 among performing loans), lower initial debt-to-income ratios (31% against 34%), lower current loan-to-value ratios (53% against 60%) and slightly lower interest rates—a pattern that remained stable over the entire 2021–2025 period.

1.2 Logistic regression results

The logistic regression confirms that the observed negative relationship is not merely a reflection of borrowers' wealth. The EPC value of the property enters the model with a negative and highly statistically significant coefficient (–0.69, $p<0.001$), meaning that a higher energy performance is associated with a lower probability of default **even after controlling for borrower, loan and property characteristics.**

Including the energy efficiency variable improves the explanatory power of the model—the pseudo-R^2 rises from 0.017 to 0.027 and the log-likelihood improves from –2,613 to –2,587—and increases its discriminatory power (area under the ROC curve) in each of the three regional models. The improvement in model fit is also observed within the sub-group of low-income borrowers.

1.3 Survival analysis results

The survival analysis provides further evidence on the timing of default. **The Kaplan–Meier estimates establish a strict risk hierarchy: the most energy efficient properties present the longest survival time (longest period before defaulting)**. Indeed, the median survival time of mortgages secured by high-energy- efficiency properties (EPC classes A–B) is 47 months, compared with 39 months for medium-efficiency properties (classes C–D), 29

months for low-efficiency properties (classes E–G) and 18 months for properties without a valid certificate.

The Cox proportional hazards model corroborates this ranking: in the most complete specification, which controls for loan characteristics as well as year and country fixed effects, mortgages on low-efficiency properties face a 43% higher instantaneous risk of default than mortgages on high-efficiency properties (hazard ratio of 1.43), and mortgages on medium-efficiency properties a 23% higher risk (hazard ratio of 1.23). Properties without a valid certificate display by far the highest hazard, which underlines the financial vulnerability associated with the absence of energy performance information.

1.4 Additional key takeaways

A distinctive result of the analysis is the temporal stability of the energy efficiency effect. Over the 2021–2024 origination vintages, the predictive power of traditional underwriting metrics—original loan-to-value, initial debt-to-income and initial interest rate—proved volatile and in some years even reversed, whereas **the relationship between energy efficiency and default remained consistent, including during the adverse macroeconomic conditions (rising interest rates and inflation) experienced in 2023–2024.**

1.5 Links with previous academic findings

These results corroborate and extend previous research carried out by members of the ENGAGE Consortium. **Billio et al. (2022),** combining **Dutch loan-level mortgage data** with building energy ratings and applying logistic regression and extended Cox models, found that **building energy efficiency is negatively associated with the probability of mortgage default after controlling for borrower, loan and property characteristics**, with evidence consistent with an income channel whereby lower energy expenses increase borrowers' disposable income—a benefit that is particularly relevant for lower-income households.

More recently, **Billio et al. (2025)**, using loan-level data on **securitised mortgages across the European Union reported through the ESMA templates** and harmonising EPC information across Member States through a common metric (energy consumption per square metre per year), found that **loans included in Green-labelled RMBS exhibit 47.6% lower delinquency rates than loans in non-Green RMBS,** and that the **negative impact of poor energy efficiency on delinquency is amplified for low-income borrowers and during periods of high energy inflation**, as higher utility costs reduce disposable income.

The results of the ENGAGE analysis, based on a broader multi-country sample and an updated observation window, confirm these findings.

Overall, the research conducted provides strong empirical evidence that home energy efficiency constitutes a fundamental determinant of mortgage default risk. The results carry significant implications for the financial sector, demonstrating that the integration of environmental sustainability factors into credit risk models extends beyond the realm of corporate social responsibility and represents a pragmatic approach to achieving more accurate and resilient credit assessments.

The empirical findings validate the study's core hypotheses. Specifically, energy efficiency has a direct influence on the Probability of Default (PD) by enhancing borrower financial resilience—lower energy expenditures increase household liquidity and strengthen repayment capacity. Moreover, the observed stability of this relationship over time suggests that a property's energy performance can function as a robust indicator of default risk and serve as a persistent and reliable predictor of long-term mortgage creditworthiness.

3. Policy recommendations based on the research results

I. The availability of energy efficiency data is essential for the performance of research analysis on the credit-related implications of energy efficiency and to increase the sustainable mortgage portfolios by lending institutions.

   On these grounds, the ENGAGE Consortium recommends adding to the ESMA Templates the relevant additional fields that enable the qualification of transactions as "sustainable" according to the EU Taxonomy Regulation and its delegated acts, extending loan-by-loan data with specific collateral energy efficiency information.

   This is especially required for granular data regarding renovations, as well as for the disclosure requirements for compliance with the Do Not Significant Harm principle for the various environmental objectives. The challenges relate, amongst others, to personal data protection restrictions and to the lack of comparable indicators across jurisdictions -due to inconsistent national legislation regulating the access (or lack of it open access) to the Energy Performance Certificates (EPCs), for instance-.

II. In line with the Joint ESAs-ECB Statement disclosure on climate change for structured finance products as of 13 March 2023 ("**ESAs-ECB Statement**") to develop a dedicated reporting template for EU Taxonomy compliance, the ENGAGE Consortium delivered a proposed set of fields to improve the harmonisation of sustainability disclosures for mortgages.

The ENGAGE Consortium believes that the addition of a limited number of sustainability indicators is the best way forward to achieve the goals of the ESAs-ECB Statement for structure finance products taking into consideration the more granular existing reporting requirements used by market participants.

III. The ENGAGE Consortium also agrees with the ECB staff response to the ESMA consultation paper on the securitisation disclosure templates under Article 7 of the Securitisation Regulation with regards to the need for a set of climate-related metrics that align with other EU regulatory criteria, such as the EU taxonomy or SFDR disclosure requirements, with the aim of harmonising the reporting burden for originators.

More specifically, the ENGAGE Consortium supports the ECB staff suggestion to include the following fields like the primary energy demand (kWh/m2 per year) or the issuance date of the EPC in the technical standards for disclosure requirements under the Securitisation Regulation.

4. References and papers on the topic

1. Buildings' Energy Efficiency and the Probability of Mortgage Default: The Dutch Case (JREFE)

Billio M., M. Costola, L. Pelizzon and M. Riedel (2022), Buildings' Energy Efficiency and the Probability of Mortgage Default: The Dutch Case, *Journal of Real Estate Finance and Economics*, 65/3, 419-450, https://doi.org/10.1007/s11146-021-09838-0.

2. The European RMBS paper (SSRN)

Billio M., M. Dragotto, A. Dufour, S. Segato and S. Varotto (2025), Energy Costs and Default Risk in Green Mortgage Securitisations, SSRN Working Paper No. 5206209, https://ssrn.com/abstract=5206209 (DOI 10.2139/ssrn.5206209).

3. Creditworthiness and buildings' energy efficiency in the Italian mortgage market (SAFE WP 352)

Billio M., M. Costola, L. Pelizzon and M. Riedel (2022), Creditworthiness and buildings' energy efficiency in the Italian mortgage market, SAFE Working Paper No. 352 (SSRN 4149430). About 70,000 mortgages from four Italian institutions matched to EPCs; negative relation between energy efficiency and default; improved ROC curve. Published as Chapter 13, "Creditworthiness and Buildings' Energy Efficiency in the Mortgage Market", in E. Jurczenko

(ed.), *Climate Investing: New Strategies and Implementation Challenges*, Wiley–ISTE. Academic version of the analysis of the Italian data contained in the EeDaPP D5.7 report.

4. Italian CRIF data, Belgian and Portuguese data (EeDaPP D5.7, 2020)

Billio M., M. Costola, S. Fumarola, I. Hristova, L. Pelizzon, F. Portioli, M. Riedel and D. Vergari (2020), Final report on correlation analysis between energy efficiency and risk, EeDaPP Deliverable D5.7 (H2020 GA 784979), ed. L. Bertalot (EMF-ECBC), August 2020. Italian CRIF data (about 73,000 loans), Belgian and Portuguese data; logit and Cox models; negative correlation, significant effect for class A.

5. Analysis of Belgium, Italy, the Netherlands and the United Kingdom (EeMAP D5.3, 2019)

Baccega T., A. Bedin, M. Billio, I. Hristova and M. Riedel (eds. M. Billio and L. Pelizzon) (2019), Technical Report on the Econometric Assessment and Results, EeMAP Deliverable D5.3 (H2020 GA 746205), 30 April 2019. Analysis of Belgium, Italy, the Netherlands and the United Kingdom; the origin of the Dutch analysis later published in JREFE.

6. Related works

- Billio M., R. Casarin, M. Costola and V. Veggente (2024), Learning from experts: Energy efficiency in residential buildings, *Energy Economics*, 136, 107650, https://doi.org/10.1016/j.eneco.2024.107650 (earlier SAFE WP 403, 2023). Machine-learning prediction of energy efficiency from EPC data (United Kingdom and Italy); cites both the Dutch and the Italian paper.
- Billio M., A. Dufour, S. Segato and S. Varotto (2023), Complexity and the default risk of mortgage-backed securities, *Journal of Banking & Finance*, 155, 106993, https://doi.org/10.1016/j.jbankfin.2023.106993. Same EDW loan-level data on European RMBS; companion to the SSRN paper (the "Billio et al. 2023" cited in Dragotto's thesis).

5. Citations

Citing the paper *Buildings' Energy Efficiency and the Probability of Mortgage Default: The Dutch Case* (JREFE 2022)

1. Thebault L. and U. Jamil (2024), Is Energy Efficiency Credit Relevant?, in EMF-ECBC, *HYPOSTAT 2024*, pp. 11-16, PDF. French and Dutch securitised mortgages originated in 2016-2019; worse performance for EPC classes D-G, strongest effect for lower-income borrowers.
2. Fatouh M., B. Guin and H. Unal (2026), Product innovation in the UK mortgage market: the case of green mortgages, Bank of England Staff Working Paper No. 1167, January

2026. Cites Billio et al. (2022) for energy efficiency as a dimension of credit risk (cash-flow channel).

3. Serrano Rodriguez E., D. Barmes and A. Niño Corredor (2026), Climate and collateral: the design and scope of the Eurosystem's Climate Factor, CETEx – LSE, policy report, May 2026. Cites Billio et al. (2022) and Thebault & Jamil (2024) as evidence of the link between energy efficiency and credit risk, in support of extending the ECB climate factor to ABS and credit claims.
4. Brolinson B., W.M. Doerner, A.J. Pollestad and M.J. Seiler (2024), European Energy Crisis: Did Electricity Prices Shock Real Estate Markets?, FHFA Staff Working Paper 24-10, December 2024; published in *Journal of Environmental Economics and Management* (2026). Cites the Dutch paper for the lower default probability of energy-efficient homes, especially for lower-income households.
5. Contat J., C. Hopkins, L. Mejia and M. Suandi (2024), When climate meets real estate: A survey of the literature, *Real Estate Economics*, 52/3, 618-659 (earlier FHFA Staff Working Paper 23-05, 2023). Cites both the Dutch paper and the Italian working paper.

1. Gróf G., B. Sárvári and B. Várgedő (2024), Az energiahatékonyság szerepe a jelzáloghitelek csődvalószínűségében és a tőkekövetelmények meghatározásában [The role of mortgage energy efficiency in the probability of default and in determining capital requirements], *Közgazdasági Szemle*, 71/6, 653-670, record. Disposable-income channel and the MNB preferential capital requirement programme for green mortgages.
2. Hajnal G., A.M. Palicz and S. Winkler (2022), Impact of Energy Rating on House Prices and Lending Rates, *Financial and Economic Review* (MNB), 21/4, 29-56, https://doi.org/10.33893/FER.21.4.29.
3. Giraudet L.-G., A. Petronevich and L. Faucheux (2021), Differentiated green loans, *Energy Policy*, 149, https://doi.org/10.1016/j.enpol.2020.111861.

Citing the SSRN paper (2025)

9. Lionetti V., T. Loizzo, L. Ridi and F. Schimperna (2026), Green Loans: A proposal for a simplified EU definition, Banca d'Italia, Notes on Financial Stability and Supervision No. 52, October 2026. Cites Billio et al. (2025) in support of the lower riskiness of mortgages on energy-efficient properties (energy-cost channel); proposes an EU definition of green loan, in line with the letter's recommendations.

Annex 1: Description of the ENGAGE for ESG initiative

ENGAGE Consortium:

- European DataWarehouse GmbH (EDW) is an ESMA-designated Securitisation Repository and a Eurosystem repository for ABS, pools of additional credit claims.
- Hypoport B.V. (HYP) is a specialist IT company, developer of software solutions for the financial sector.
- Università Ca' Foscari (UNIVE) is a pioneer university in sustainable finance programmes and research.
- Unión de Créditos Inmobiliarios, S.A., Establecimiento Financiero de Crédito (UCI) is a specialist entity in sustainable financing for mortgages and loans in the Spanish and Portuguese markets.
- Nationale-Nederlanden Bank N.V. (NN Bank) is an innovative sustainable mortgage loan originator in the Dutch market.
- Dexai s.r.l. (DEXAI) is a consultancy company expert in compliance of new technologies with legal and ethical standards.

ENGAGE for ESG is an initiative co-funded by the European Union and launched by the six institutions from across Europe mentioned above (the "**ENGAGE Consortium**") with the purpose of creating a standardised and harmonised disclosure framework for mortgages and renovation loans that contributes to the activation of energy efficiency investments for the residential building stock. The initiative is also contributing to the goals of the Renovation Wave and supporting the implementation of the Energy Performance of Buildings Directive recast (recast EPBD).

Since its inception in November 2022, the initiative has been focusing on developing standardised disclosure templates for mortgage and home renovation loans (ENGAGE Templates) in line with Regulation (EU) 2020/852 (the "**Taxonomy Regulation**") and Commission Delegated Regulation (EU) 2021/2139 (the "**Climate Delegated Act**") to facilitate the sustainability reporting for financial institutions and improve transparency vis-à-vis investors. In fact, the ENGAGE Consortium is enhancing existing loan disclosure frameworks based on the technical standards on disclosure requirements under the Securitisation Regulation (the "**ESMA Templates**") through a flexible system of add-on templates for various regulatory standards. These add-ons are market-designed and built upon the principes of transparency, data availability and governance.

The ENGAGE Templates version 1.2 were released in September 2025 and include the data elements that allow financial institutions to disclose the alignment of their mortgages and home renovation loans with EU Taxonomy requirements.

The ENGAGE Templates have been operationalised through a dedicated IT infrastructure, the ENGAGE Portal. ENGAGE Portal users are now able to evaluate ESG criteria and to use the infrastructure as a secure data room for sustainable disclosures, starting with the required disclosures to check the EU Taxonomy- alignment.

Two European lenders, Unión de Créditos Inmobiliarios, S.A. and Nationale-Nederlanden Bank N.V. have been submitting data to the ENGAGE Portal according to the ENGAGE Templates for Netherlands, Spain and Portugal since 2023. Onesto, FIDEO Gestion, and Domivest have recently joined the initiative as ENGAGE Portal users.

Market participants have positively welcomed the ENGAGE Templates and Portal, in particular, with regards to the conversion of the regulatory requirements of the EU Taxonomy into concrete data fields.

The ENGAGE for ESG initiative has consolidated its position in the market and aims to become a widespread industry standard in 2025. By way of example, the ENGAGE Templates were showcased as a best practice by Climate Strategy & Partners in their report *Mortgage Portfolio Standards: The EPBD Delegated Act process can synchronise regulatory developments, climate initiatives, and EU technologies to offer a window into the future*[2].

[2] Report available at https://www.climatestrategy.es/en/informe_29.php

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