AEW RESEARCH

Managing & Pricing Climate Risk

February 2020

AEW

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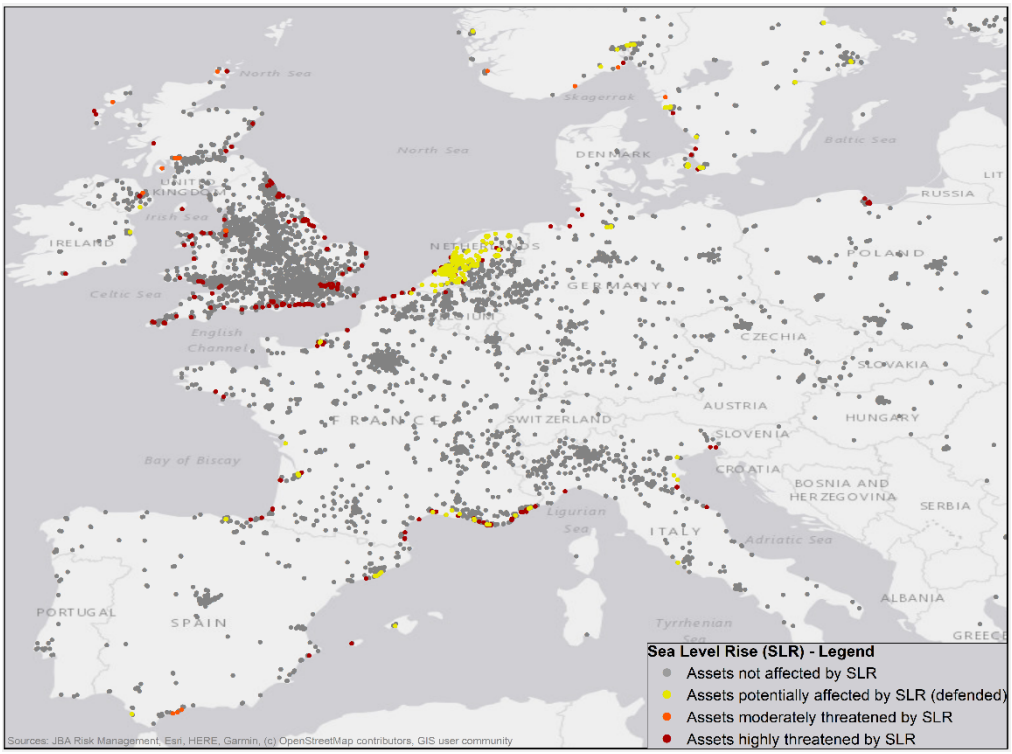
HOW TO BEST MANAGE CLIMATE CHANGE RELATED RISKS?

River flooding after storms Ciara and Dennis in February, the Australian bushfires and the declaration of 'climate emergency' as the 2019 word of the year by Oxford Dictionaries highlight the seismic shift in public opinion and increased media, government and investor focus on Environmental, Social and Governance (ESG) issues. New government policies are now being backed by precise scientific research which are already impacting on consumer, corporate and investor decision making. A myriad of different projects around climate change are under way, however, the 2015 Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) remains the leading global initiative. This agreement commits signatory governments to policies aimed keeping a global temperature rise this century well below 2 degree Celsius.

As real estate (directly and indirectly) contributes to 36% of greenhouse gas (GHG) emissions globally, a deep understanding of climate change related risks for the commercial real estate sector is starting to develop. Climate change risks include both direct physical and indirect transitional risks. New tools are emerging to help improve this. Among others, Munich Re's new assessment tool addresses the direct physical impact of sea level rise and other climate related hazards. Also, the new Carbon Risk Real Estate Monitor (CRREM) is a practical tool that measures regulatory transition risk. Non-compliance with EU determined future energy and GHG reduction targets is unlikely to trigger assets to become stranded in the short term, i.e. impossible to sell or requiring costly capital expenditure, but when GHG targets are not met by the specified dates, EU and local governments are likely to become stricter in enforcing their targets and policies. This could increase the financial risk of non-compliance significantly. In the meantime, investors themselves are already implementing better energy efficiency and GHG intensity reduction with the emerging new tools. This report aims to explain these risks and illustrate the potential use of these new tools in order for investors to control them as far as possible.

SEA LEVEL RISE A 'CONCERN' FOR LOCATIONS NOT BEING ABLE TO MITIGATE ACCORDINGLY

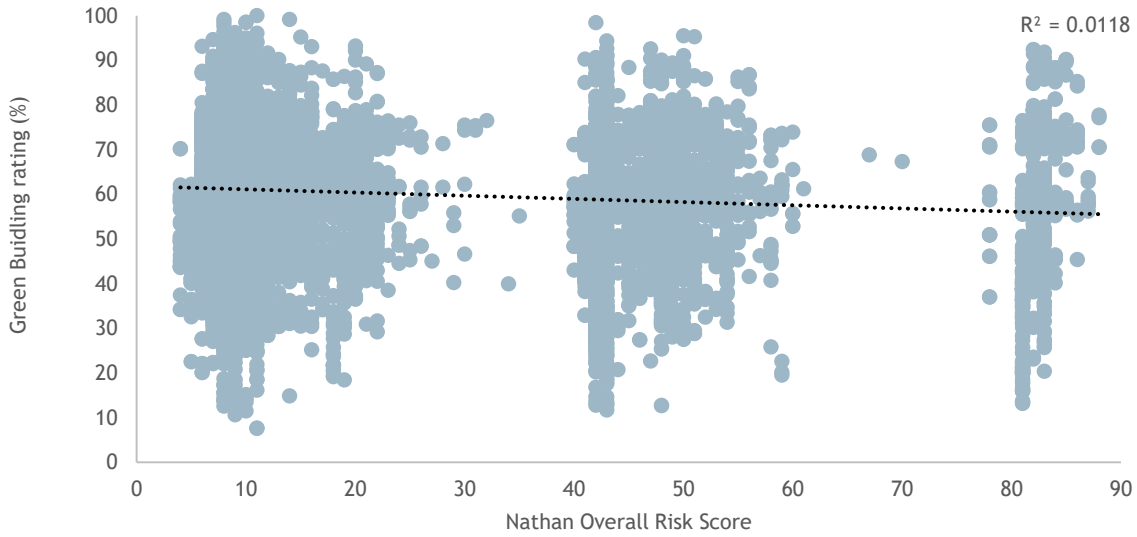


Sources: Greenbook, Munich Re & AEW

EXECUTIVE SUMMARY: NEW TOOLS TO BETTER PRICE CLIMATE RISKS

- As real estate assets face significant climate change related risks, investors are shifting their focus to avoid obsolescence risk.
- In this report, we consider the two main sources of climate related risks for real estate investors:
  - Physical risks of damage and disruption to buildings as a result of storms, river flooding, sea level rise, heat and droughts could leave some assets stranded. The increased cost of insurance or climate change adaption measures might render buildings impossible to rent or sell;
  - Transitional risks associated with climate change mitigation, which include regulatory risks such as energy and GHG reduction requirements but also market expectations, technological and reputational changes. Upcoming energy and GHG reduction regulatory targets are likely to result in a shift in focus from current building certifications towards a more climate risk focus approach to be achieved.
- Two acute and five chronic physical climate related hazards are quantified by reinsurer Munich Re using their natural catastrophe risk models calibrated with their historical claims data. Data on a diversified sample portfolio of nearly 20,000 European buildings allows us to show the main results for each specific risk on location-level.
- In the case of the change in daily temperature, we show a consistent northwest to southeast pattern across the sample portfolio. For the precipitation stress index we see a similar pattern with some variation in the Alps. For sea level rise, our sample shows that despite the Netherlands being largely below sea level, sufficient sea level rise protection mitigates the risk significantly.
- Future regulatory change on Energy reduction and GHG intensity play a crucial role in transitional risk. GHG can be measured by the Carbon Risk Real Estate Monitor (CRREM). Current GHG intensity varies widely between EU countries, due to their existing energy mix. As a result, there are different starting points for landlords in different countries and their future requirement to reduce GHG intensity.
- France stands out with a very low current GHG intensity mainly due to its reliance on nuclear energy which represents 70% of the energy produced. This also leaves it with a not very steep GHG reduction pathway. Italy, Spain and CEE have much more to do in this respect due to a low percentage of renewable energy in their current energy mix.
- GHG intensity varies also by property type, with hotels and office among the most intensive sectors and residential and logistics among the least intensive sectors. Based on our analysis, investors in European offices are not (yet) pricing in climate change.
- CRREM has recently been an operational tool that shows the percentage of portfolios that could become non-compliant due to regulatory change alone and the timings of such non-compliance. We note that there is likely to be a significant delay in governments implementing the GHG intensity target in local laws and enforcing them. This delays the impact of non-compliance and also short term risk.
- Non-compliance with EU determined future energy and GHG reduction targets is unlikely to trigger assets to become stranded in the short term, given that current national legislation is delayed and the level of fines is very low, but, when GHG targets are not met at the specified dates in future, EU and local governments are likely to become stricter in enforcing their targets and policies. This could increase the financial risk of non-compliance significantly.
- Policy debates also highlight the possibility for a market-based policy such as a European carbon tax to accelerate the de-carbonisation of commercial real estate. Such a carbon tax could also trigger some energy inefficient and GHG-intense assets to become stranded.

CURRENT BUILDING CERTIFICATIONS LACK CLIMATE RISK FOCUS

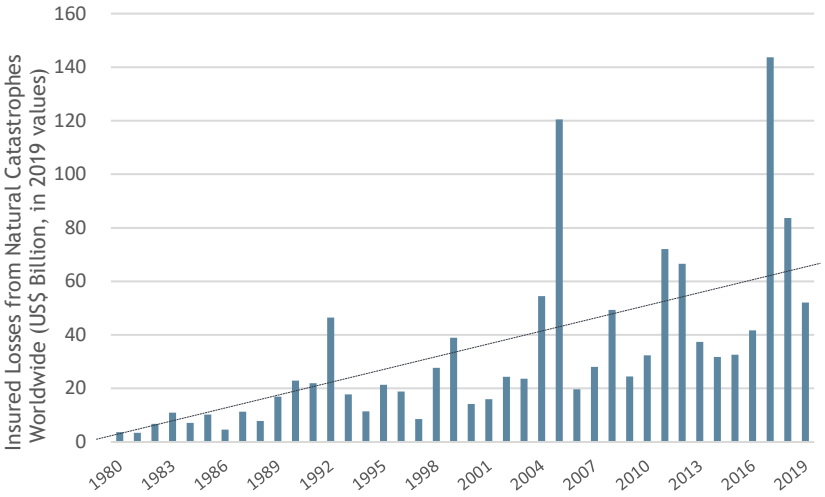


Sources: Greenbook, Munich Re & AEW

SECTION 1: ESG FOCUS IS SHIFTING TO PHYSICAL AND TRANSITION RISKS

CLAIMS FROM CATASTROPHE LOSSES SHOW A STRONG UPWARD TREND

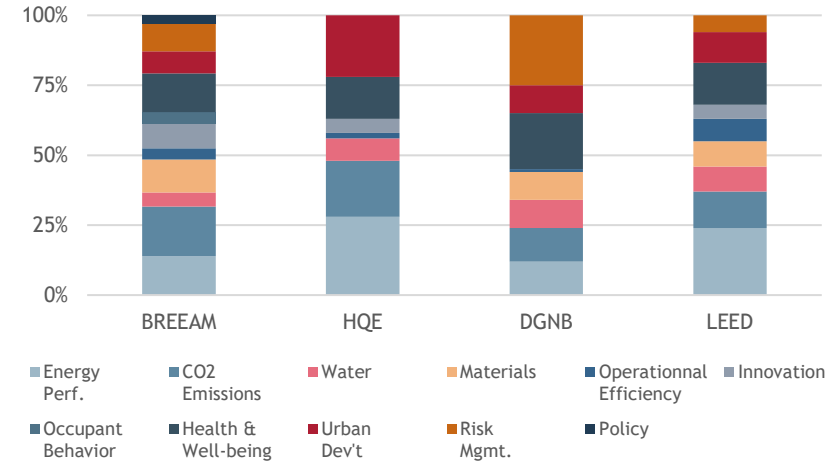
- Climate change risks have increased as illustrated by growing insured natural catastrophe losses over the past 40 years.
- Based on growing public support and political initiatives, global agreements, EU directives and national laws will likely require investors to adapt to climate change risks.
- Real estate contributes nearly 36% of green-house gas (GHG) emissions and will become a bigger focus. Therefore we will have to adapt to both direct physical risk of climate related catastrophes as well as the indirect transitional risk associated with energy and GHG reduction regulatory requirements.
- Building and fund-level certifications have not been designed to fully deal with these risks, but, there are innovative new tools available to manage climate related risks.



Sources: Munich Re & AEW

BUILDING CERTIFICATIONS DO NOT ADDRESS CLIMATE RISKS

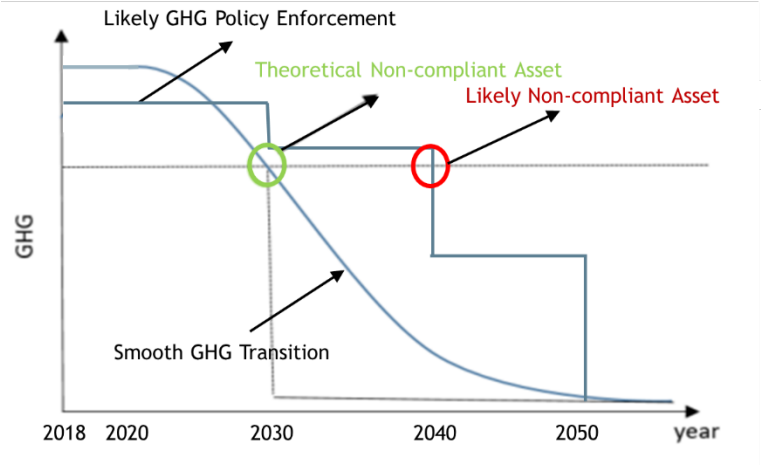
- As discussed in our May-19 report, there is a myriad of building certifications being used in Europe, with BREEAM and LEED being the leaders.
- This chart shows only the four leading building certifications and the many different factor weights used in them.
- It might be politically unappealing for the EU to adopt a non-EU standard certification.
- It is clear that most certifications take (possibly) many different factors into account. As a result, they might lack the precise focus investors need to meet more specific energy consumption or GHG emission targets required by current regulations.



Sources: Green Street Advisors & AEW

STEPPED REGULATORY ENFORCEMENT TO DELAY TRANSITION RISK

- This chart illustrates the risk of an asset becoming "stranded" by non-compliance.
- Our horizontal grey line shows the current and stable GHG intensity of an existing building.
- The smooth blue line represents a gradual theoretical GHG transition, while the stepped blue line shows how future regulations might be enforced to require lower GHG intensities.
- Initially the building is compliant with both the smooth and policy targets without any action.
- It will theoretically become stranded by 2030.
- But a delay in the actual enforcement of regulations means that the non-compliant building will not actually become stranded until 2040. The introduction of a carbon tax might counteract this delay though.



Sources: CRREM & AEW

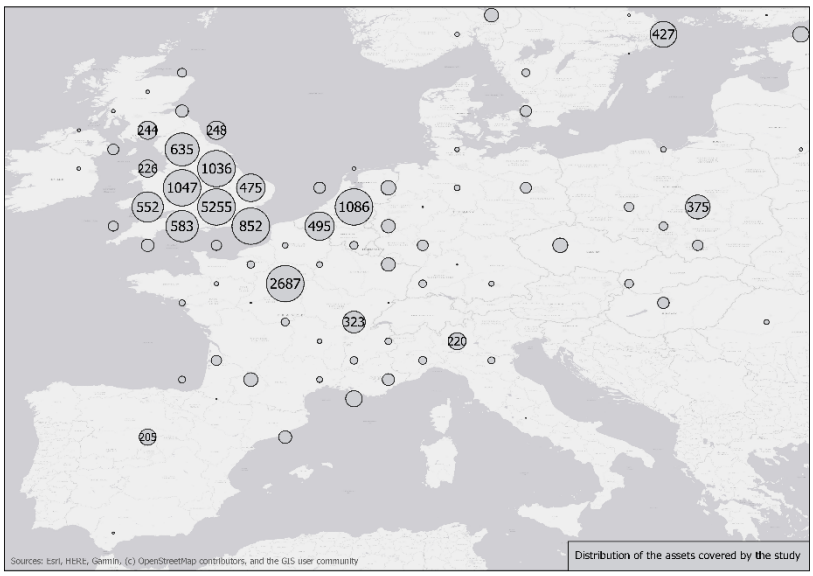
SECTION 2: FUTURE CLIMATE RELATED RISKS QUANTIFIED

CURRENT HAZARD RISKS BASIS FOR FUTURE CLIMATE RELATED RISKS

- Munich Re is one of the world's leading reinsurance companies, pricing risks on a wide range of different reinsurance policies for their insurance clients. Based on their natural catastrophe risk models and historical claims experience, they have a well-established hazard scoring tool, named Nathan. It scores twelve different hazard risks for specific locations as of today based on past data.
- More recently, Munich Re has started quantifying seven future climate hazards, as shown in the table. Only the two acute hazards are in Nathan.
- Munich Re shared with AEW scores on all twelve Nathan hazards and five of the seven future climate change hazards for a full sample of around twenty thousand buildings across Europe for which we also have information on their building certificate and property type (from the Greenbook certification database). Please see top map to the right.

	Climate related Hazard	Type of Hazard
1	Tropical cyclones	Acute
2	River flood	Acute
3	Sea level rise index	Chronic
4	Fire Weather Index	Chronic
5	Drought Index	Chronic
6	Heat stress index	Chronic
7	Precipitation Stress Index	Chronic

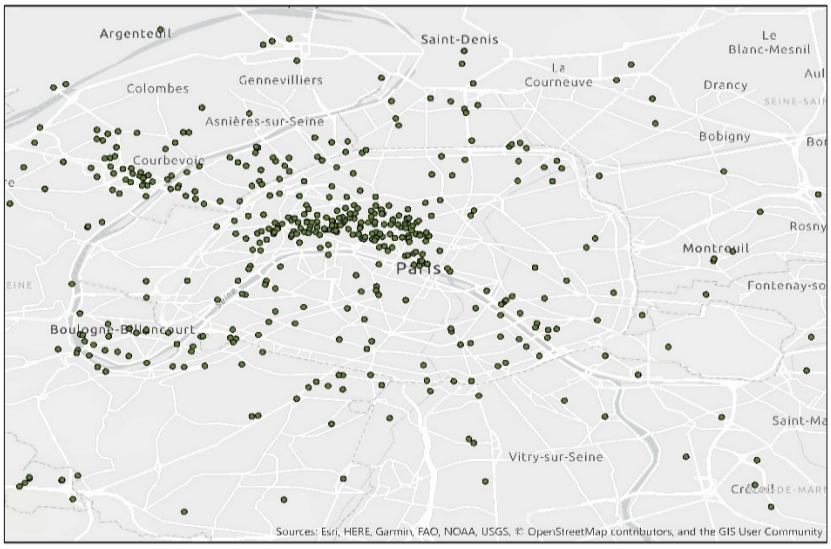
Sources: Munich Re & AEW



Sources: Greenbook, Munich Re & AEW

PAN-EUROPEAN DATA SAMPLE ALLOWS FOR IN-DEPTH ANALYSES

- Please note that there are different (2050 and 2100) projections for the RCP scenarios 4.5 and 8.5[1] for GHG concentration based on the UN's inter-governmental panel on climate change framework (IPCC). IPCC supports the UNFCCC, which put in place the Paris Agreement sealed in 2015.
- Our sample covers multiple property types with 35% of our buildings being mixed-use, while 18% and 13% are retail and office buildings, respectively.
- As our map highlights, the highest density of buildings is in the UK (60%), followed by France (10%) and the Netherlands (7%).
- When we look at the density of observations in Functional Urban Areas (FUA's as defined by the OECD) we see that 46% of the buildings are located in large functional urban areas of over 1.5 million inhabitants, with 30% in metropolitan FUAs of between 0.5 and 1.5 million.
- London's FUA consist of 48% of the observations, while Paris has 13% and Amsterdam has 4%.
- The second largest FUA in our data sample is Paris, with over 1,200 certified buildings, which are displayed on the second map to the right.



Sources: Greenbook, Munich Re & AEW

[1] RCP stands for Representative Concentration Pathway, which is a greenhouse gas concentration trajectory adopted by the IPCCC in 2014. The RCP pathways describe different possible climate future scenarios, all of which are considered possible depending on the volume of GHG emitted in the years to come. RCP 4.5 and 8.5 are labelled after a possible range of values in the year 2100.

SEA LEVEL RISE, TEMPERATURE CHANGE AND PRECIPITATION STRESS ACROSS OUR SAMPLE PORTFOLIO

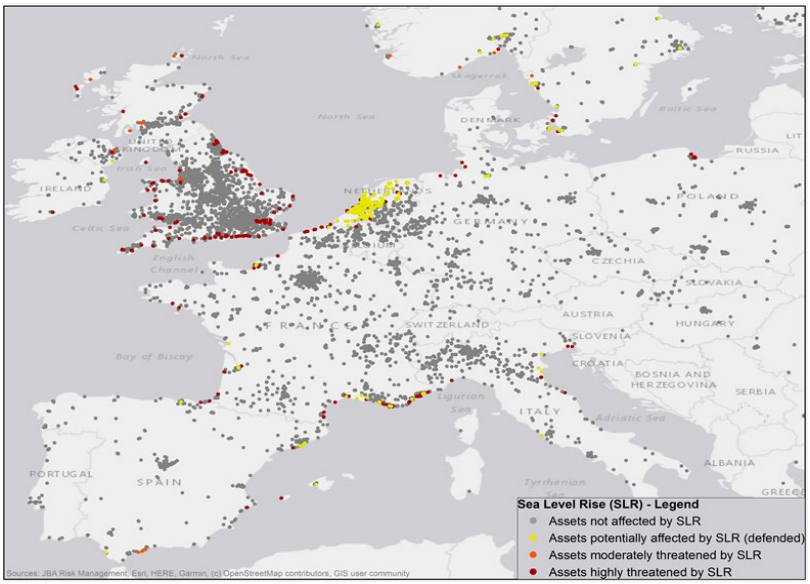
- We use sea level rise, the change in temperature and the precipitation stress index to further investigate the impact of climate change. To distinguish between the impacts, we use a colour coding that is explained in each of the legends.

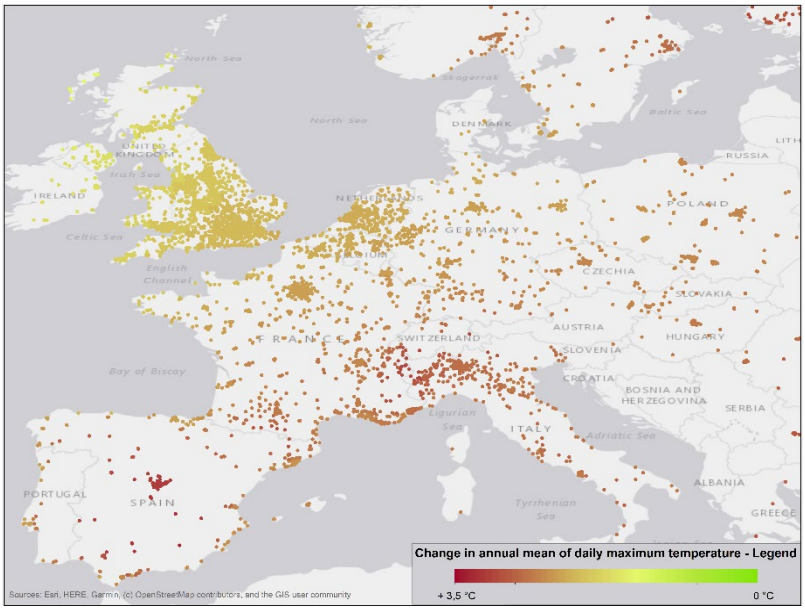
- In the first map, the sea level rise risks are shown. When we investigate sea level rise risks for the projection date of 2100 and the RCP 8.5 scenario, we observe that the highest risk corresponding to sea level rise is in the Netherlands and the United Kingdom (red dots).
- From a pure modelling point of view this might make sense as large parts of the Netherlands are below sea level and are therefore vulnerable to rising sea levels.
- However, sea level rise risk in the Netherlands is mainly mitigated, as indicated by the yellow dots, due to effective water management by government agencies.

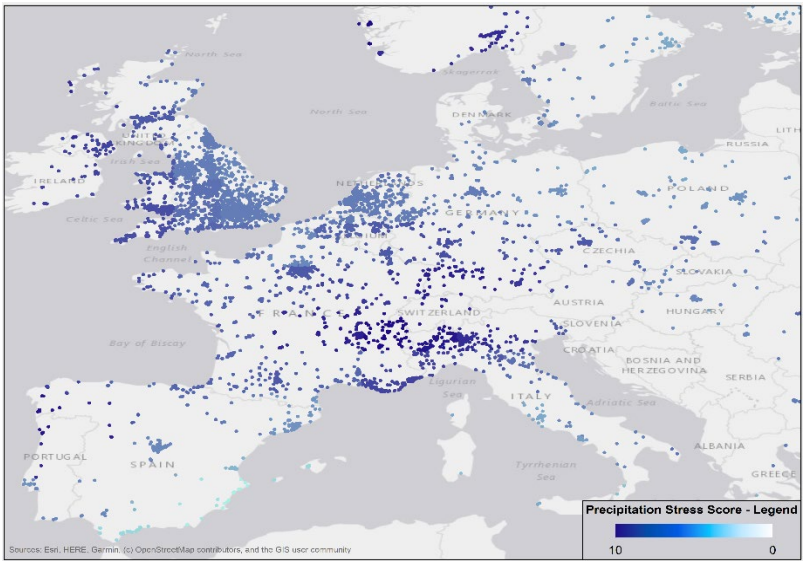
- In the next map (middle), the risk associated with temperature change (based on 2050 and 8.5 RCP scenario) shows a visible contrast between the north-west and the south-east of Europe.
- The highest change in temperature is associated with cities that, on average, already have a higher temperature (with the exception of some cities towards northern CEE).
- The lowest increase in temperature is expected to be in the Western and Northern part of the UK while the higher temperature increases are expected to be in Italy and Spain.

- In the third map, the precipitation stress index is shown, using five indicators including maximum rainfall, 5-day rainfall, and heavy rainfall days.
- The geographical pattern is less clear here and more dispersed across Europe.
- However, the highest risk associated with precipitation is in the Western part of the UK and located in the surrounding of the Alps.

- The observation of hyper-local effects of climate change related risks are not represented here but are possible with existing data. For example, the sea level rise risk differs widely in cities as local characteristics such as building structures and elevations also play a role.







Sources: Greenbook, Munich Re & AEW

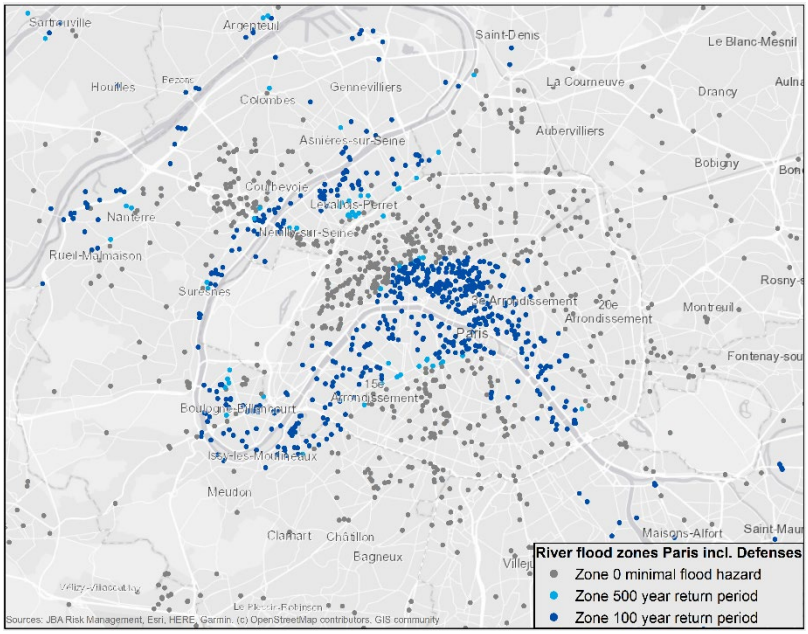
FLOOD ZONE RISK FOR TWO LARGE METROPOLITAN AREAS IN OUR SAMPLE PORTFOLIO

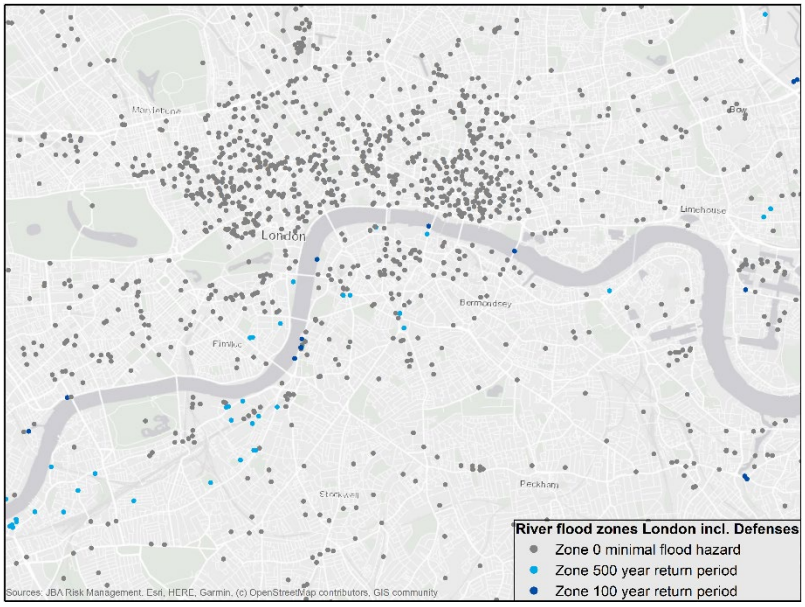
- River flooding risk is one of the most acute climate related hazards. This risk is estimated as a no hazard (grey), once in 100 year (meaning a probability of 1% per year, in dark blue) or 500 year (meaning a probability of 0.2% per year, light blue).
- Based on our sample of buildings we can show for each building the chances of a river flood (and every other), both for the current Nathan river flood zone (provided by JBA Risk Management) and for the 2050 projected river flood zones based on the RCP 8.5 scenario.
- Interestingly, we observe an increase of 10% in projected river flooding locations by 2050 in the Netherlands, Belgium, Germany, France and the UK.

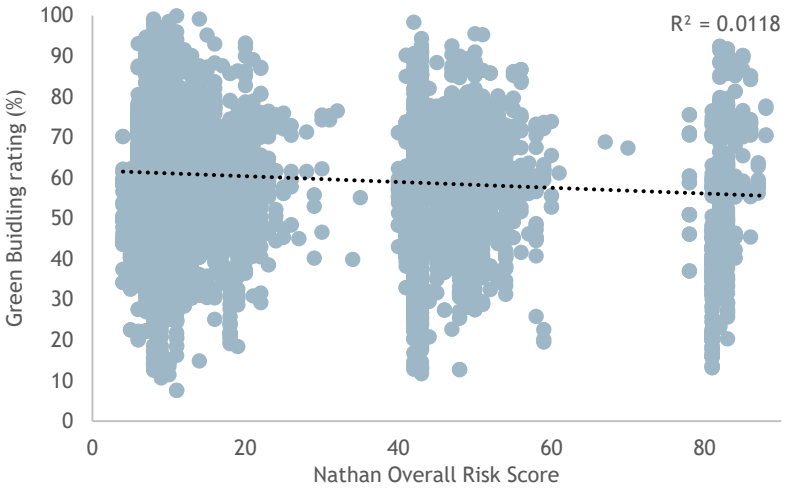
- To further investigate flooding risk, we look at Paris and London that have rivers in the centre of the city. This allows us to see the impact of flooding risk on a much more detailed local level.

- In the Paris area (first map) flooding is a greater risk than in London (middle map) when defenses (provided by JBA Risk Management) are taken into account such as the Thames Barrier.
- In the Paris area, most locations along the river are liable to flooding in case of a 100-year flood despite defenses that include four reservoir dams upstream from Paris.
- However, there are instances where very nearby buildings have different flood risks as hyperlocal differences play a role as well, such as on the elevation of the soil or the structure of the building.
- To illustrate this, we look at the avenue George V in Paris where we have a building at around 300 meters from the Seine exposed to flooding risks whereas a building on rue Raynouard (behind the Maison de la Radio in the 16ème arrondissement) at around 200 meters from the Seine is not exposed to flooding risks due to a higher elevation.

- This scatter chart shows the combined score across our 20,000 building sample with each of their green building certification scores.
- There is no clear pattern between the Nathan hazard score and green certification rating of our sample buildings.
- This is not unexpected, since certifications measure many different factors and are not specifically designed to measure climate related or other hazard risks.
- New analytical tools (like Nathan Overall Risk Score) might facilitate a shift in focus away from finding green premiums for highly certified buildings to quantifying climate related risk premiums for all new and existing buildings.
- A proper assessment of climate change requires detailed analyses of the building design, actual use, environment and connections with its surroundings.





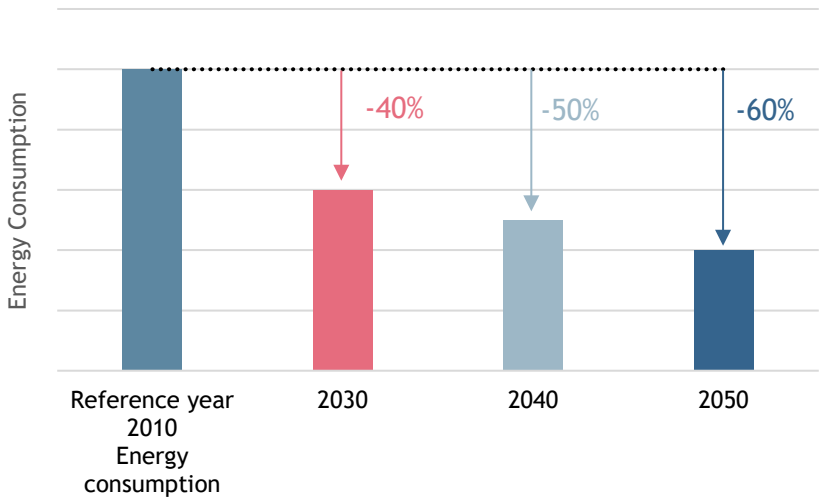


Sources: Greenbook, Munich Re & AEW

SECTION 3: TRANSITION RISK – MOVING FROM ENERGY TO GHG INTENSITY TARGETS

EPBD SETS CLEAR REDUCTION TARGETS FOR LANDLORDS

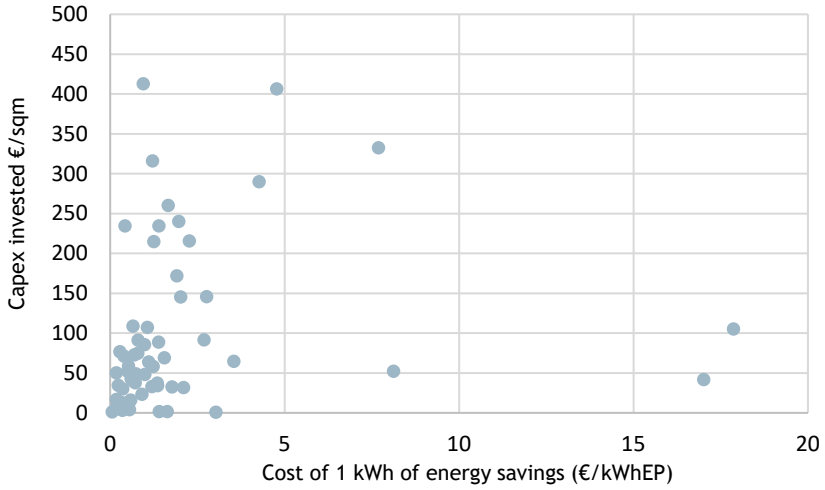
- As illustrated in the diagram the EU adopted the 2010 Energy Performance of Buildings Directive (EPBD) aiming to achieve a highly energy efficient and decarbonised building stock by 2050, with indicative milestones for 2030, 2040 and 2050.
- EPBD requires countries to set cost-optimal minimum energy performance requirements for new buildings, the renovation of existing buildings and for the replacement of major building elements (HVAC, roofs, etc.).
- Renovation of existing buildings can lead to significant energy savings.
- New buildings are also required to be nearly zero-energy buildings (NZEB) from year-end 2020.
- These energy reductions are already set in local laws and building regulations.
- Regulators are shifting their focus now to the more precise GHG intensity measures.



Sources: EU & AEW

SIGNIFICANT ENERGY SAVINGS CAN BE ACHIEVED AT VERY LIMITED COSTS

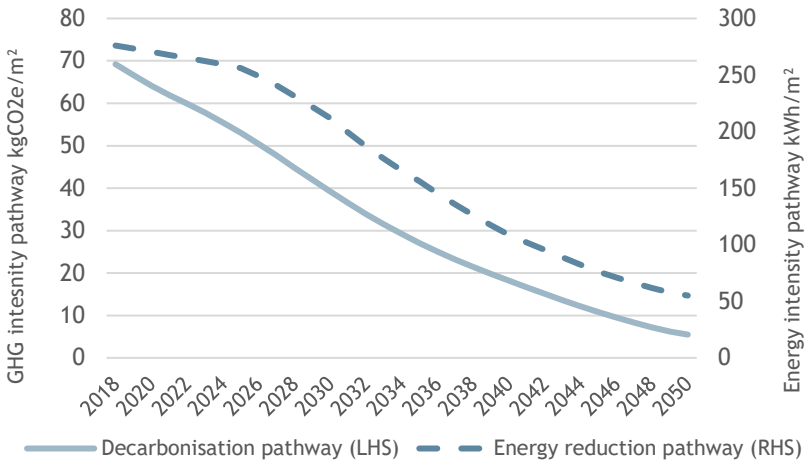
- Based on a sample of a 60+ French mixed property type portfolio, our data indicates that multi-year energy reduction programmes have delivered 1 kWh of primary energy saving at an average one-off cost of €2.00/sqm.
- This is not directly correlated to the Capex invested per sqm, as the average capex is €124 per sqm of rentable space. Energy reduction initiatives include roof and façade insulation, boiler upgrades and changes to target thermostat temperatures.
- Interestingly, the correlation between the construction year of the building and the cost of energy savings per kWh is not as high as expected. Therefore, we anticipate that the year of the last refurbishment is a more relevant indicator.



Source: AEW

SWITCHING FROM ENERGY INTENSITY 'INPUT' TO GHG INTENSITY 'OUTPUT'

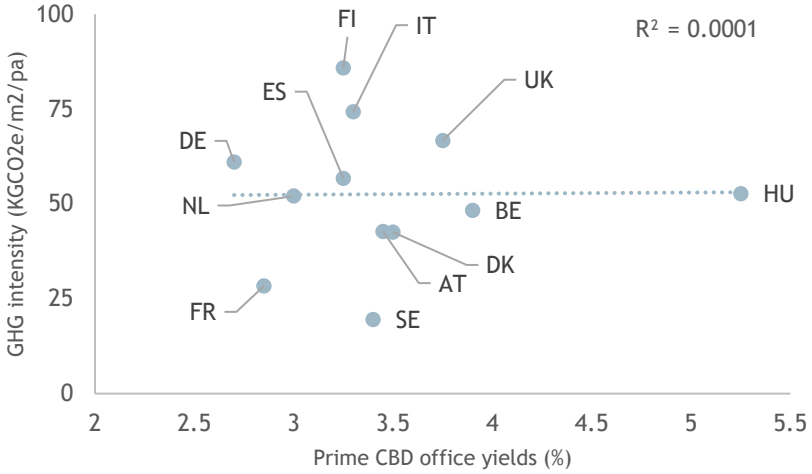
- The logical next step is for policy to align itself to climate change by moving on from energy use intensity as an input towards GHG intensity as an actual carbon output.
- To illustrate the difference, we show the UK energy reduction as well as GHG pathway by using the Carbon Risk Real Estate Monitor (CRREM) data.
- There is a similar trend between the two, however it is not a like-for-like correlation as the GHG or de-carbonisation pathway is much steeper in the beginning.
- Existing grid de-carbonisation can drive the GHG pathway despite a lower reduction in energy use.



Sources: CRREM, CBRE & AEW

CURRENT PRIME OFFICE YIELDS NOT REFLECTING GHG INTENSITY

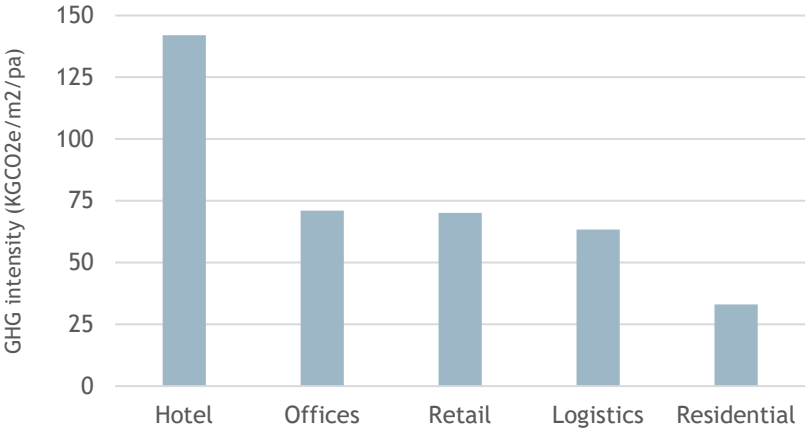
- Investors are not (yet) pricing in transition risks as implied by the absence of any correlation between GHG intensity per square meter and prime office property yield.
- Outliers can be considered as countries with similar yields but different GHG intensity. A good example is Finland and Sweden with comparable yields but different GHG intensity.
- Further research is needed that incorporates not only climate risk, but also other risk premia to isolate the impact of climate risk.



Sources: CRREM, ENTRANZE & AEW

GHG INTENSITY VARIES NOT ONLY BY COUNTRY, BUT ALSO BY PROPERTY TYPE

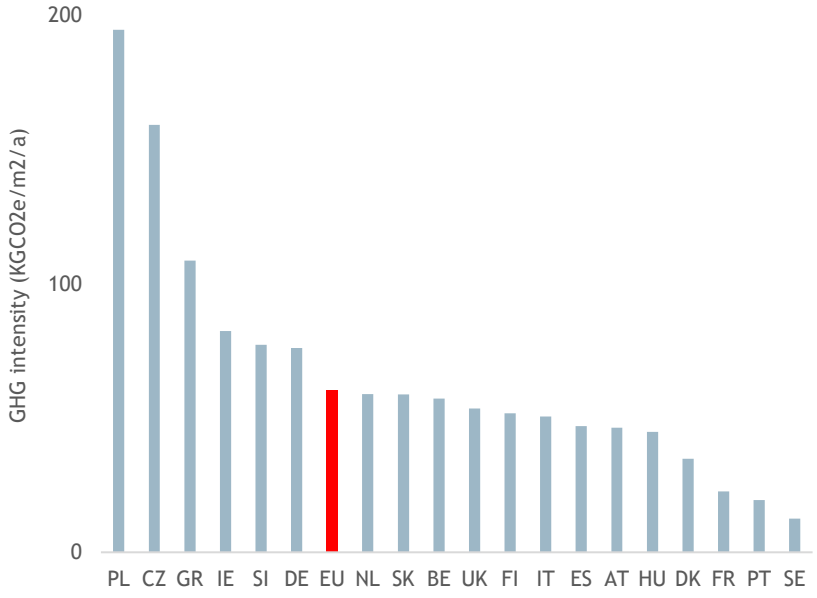
- As with country-level, current GHG intensity varies also by property type, as is illustrated in this chart.
- The EU average for hotels stands at 142 kilos of GHG (or CO2-equivalent) emissions per square meter per annum, while residential is at below 35.
- A number of other (not displayed) property types like data centers and hospitals have an above average GHG intensity per square meter.
- EU data from ENTRANZE provides detailed insight on annual GHG emissions and existing floor areas per property type per country.



Sources: CRREM & AEW

GHG INTENSITY REDUCTIONS TO 2050 VARY WIDELY ACROSS EU COUNTRIES

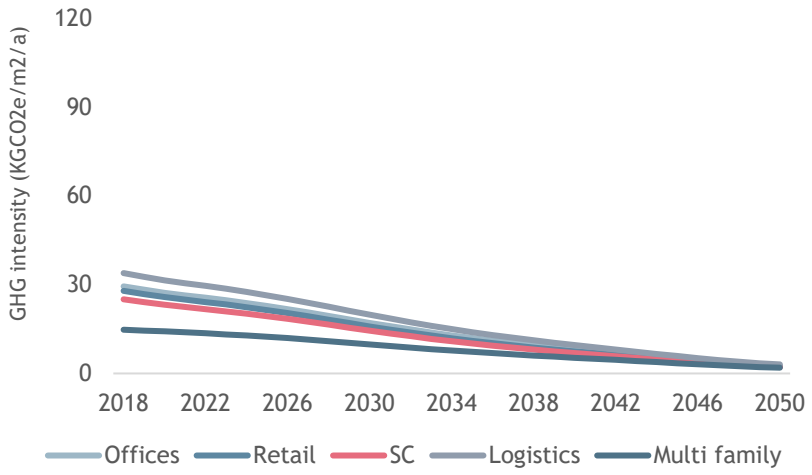
- The Paris Accord specifies a global carbon budget for the total amount of GHG to be emitted until 2050 to not exceed 2.0 degrees Celsius global warming through to 2100 (784 giga-tons of carbon emissions).
- A specific carbon budget for the European commercial real estate sector is the basis for the reduction in GHG for each EU country.
- This chart shows the wide geographical dispersion in required GHG intensity reduction by 2050 around the 60 $kgCO_2$ emission per square meter per annum European average.
- France, Denmark, Sweden and Austria benefit significantly from their high nuclear and renewable energy mix, as their required reduction is low, however, governments in Germany and a number of CEE countries have much more to do in this respect.
- Please note that it might not always be clear where the legal responsibility rests to reduce the properties' GHG intensity: landlords, tenants, national regulators and/or local governments.



Sources: CRREM & AEW

FRANCE HAS ONE OF THE EASIEST PATHWAYS TO LEADING THE EUROPEAN MARKET

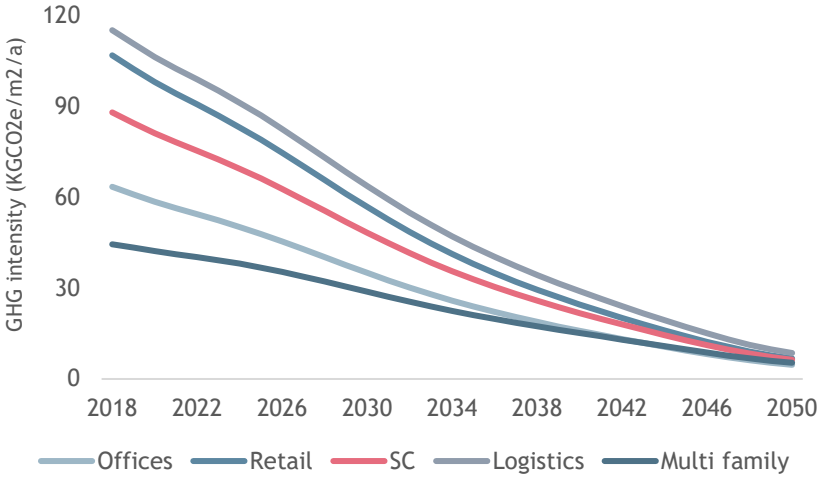
- When using consistent GHG intensity scales across leading countries, we note that France has one of the least steep pathways.
- As mentioned earlier in this report, this is mostly due to its low GHG energy grid, as France has one of the highest shares of nuclear power generation in Europe.
- Consistent with European averages, multi-family residential is currently already at a low level.
- Logistics however stands out as the highest current GHG emission property type in France, which is a significant variation from the European average.



Sources: CRREM & AEW

GERMAN RESIDENTIAL AND OFFICE IN RELATIVELY BETTER POSITION THAN LOGISTICS

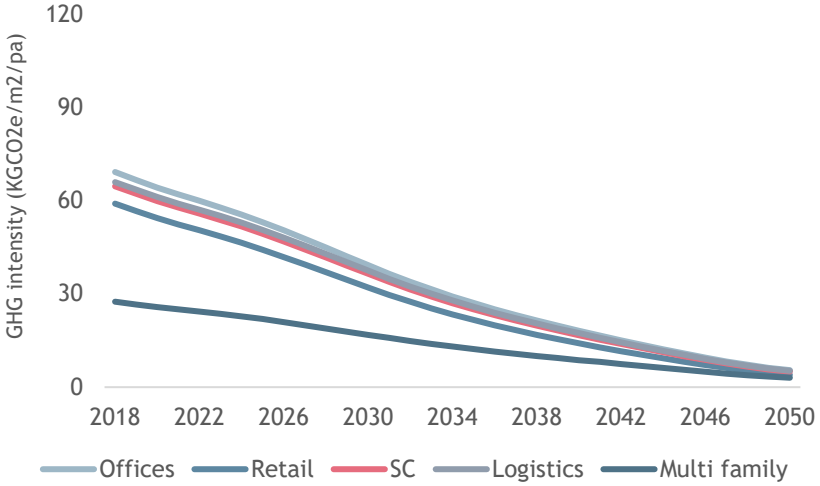
- German GHG pathways are slightly above European averages, due to its average GHG energy mix, as Germany still has a relatively high share of traditional carbon-based power generation.
- Consistent with European averages, multi-family residential is at a lower level than other property types.
- German offices also seem to be in relatively good shape compared to the European average.
- Similar to France, logistics in Germany stands out as the highest current GHG emission property type, which is a significant variation from the European average.



Sources: CRREM & AEW

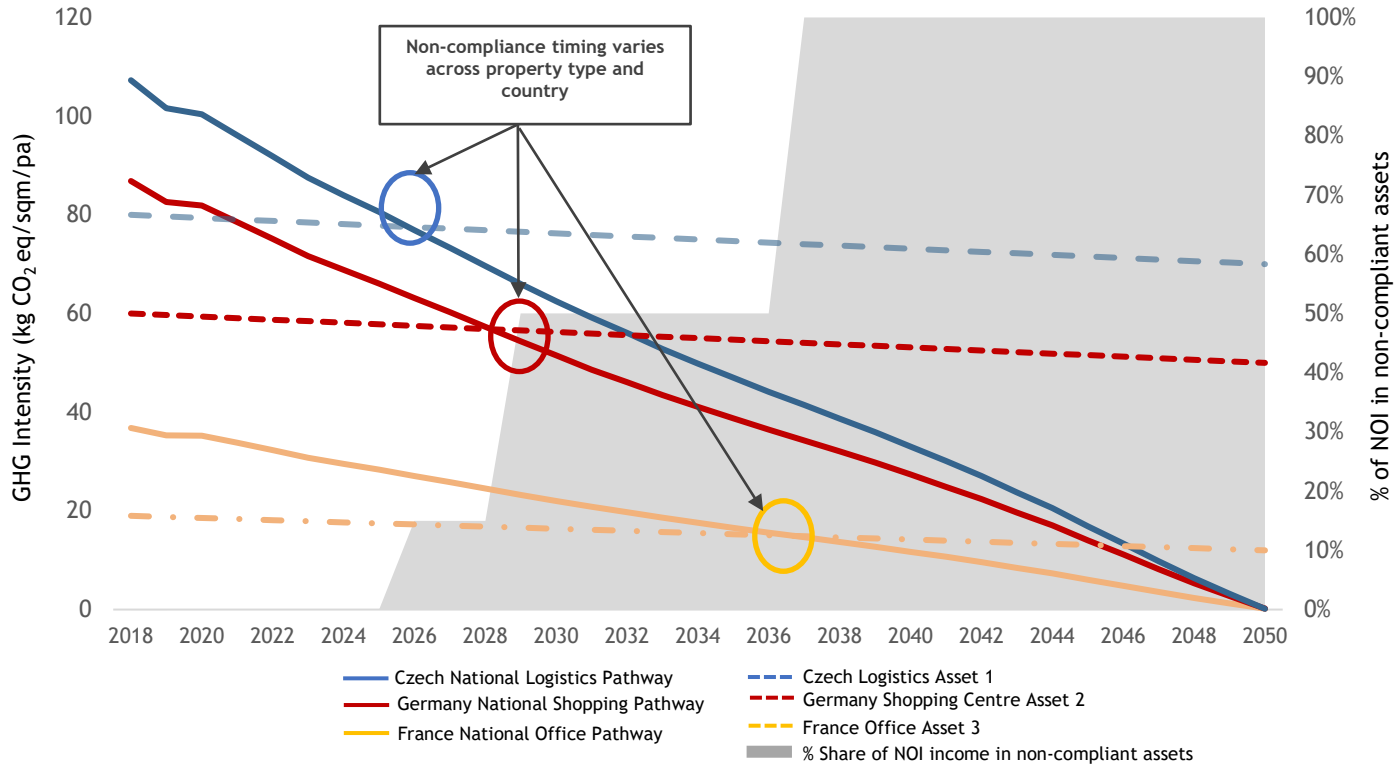
UK RESIDENTIAL IN RELATIVELY BETTER POSITION THAN OTHER PROPERTY TYPES

- UK GHG pathways are in line with the European average, due to its high share of traditional carbon-based power generation.
- Consistent with European averages, UK multi-family residential is at a lower level than other property types.
- UK shopping centers and high street retail also seem to be in relatively good shape compared to the European average.
- In contrast with Germany and France, UK offices however stand out as the highest current GHG emission property type, which is actually more similar to the European average.



Sources: CRREM & AEW

TIMING OF TRANSITION RISK ACROSS DIFFERENT ASSET SEGMENTS ACCORDING TO CRREM



Sources: CRREM & AEW

- In the above chart, we evaluate regulatory risk, one of the main Transition Risks, by using CRREM. We consider a three assets portfolio and compare its current asset-level GHG intensity pathways versus the sector and country specific GHG intensity future pathway. If the asset-level pathway is higher than the country sector specific pathway, the asset is considered to be non-compliant and potentially stranded. Our three asset portfolio assumes: (1) Logistics building in Czech Republic (Net operating income per year € 75,000); (2) Shopping Centre in Germany (Net operating income per year – € 175,000) and (3) Office building located in the Paris region (Net operating income per year – € 250,000).

- No rent indexation or capital expenditure is assumed. If we evaluate the logistics asset in the Czech Republic, i.e., the blue dotted line, we observe that the asset specific pathway intersects with the sector country specific (straight blue line) pathway in 2026 (the blue circle). This means that from 2026 the GHG intensity of our logistics asset is above the pathway, marking the asset non-compliant. If we then switch to the German Shopping Centre asset (the red dotted versus straight line), we observe that the pathway convergence is two years later in 2029. Finally, if we look at the French office asset, i.e. the yellow dotted line, it only intersects with the country specific pathway in 2037. This difference in intersection is driven by both the country-sector specific de-carbonisation pathway as well as the current (and projected) GHG intensity pathway of the assets. In the next step, we quantify this non-compliance risk for our portfolio in terms of a percentage of net operating income (the grey shaded area). We see that almost 50% of our net operating income comes from non-compliant assets by 2029 and this reaches a 100% in 2037. The pathways allows investors to investigate the impact of the GHG intensity pathways on single-assets and portfolios.

- Based on our views, non-compliance with EU determined future energy and GHG reduction targets is unlikely to trigger assets to become stranded in the short term, given that current national legislation is delayed and the level of fines is very low. However, when GHG targets are not met at the specified dates in future, EU and local governments are likely to become stricter in enforcing their targets and policies. This could increase the financial risk of non-compliance significantly.

- This highlights the need for a market-based policy such as a European carbon tax to accelerate the de-carbonisation of commercial real estate. Such a carbon tax could also trigger some energy inefficient and GHG-intense assets to become stranded.

- Reduction in the current GHG intensity or energy consumption of individual assets (or even portfolios) can be achieved by a number actions from the manager and/or owner:
  (1) Switching from traditional energy providers to renewable energy providers for high intensity assets or for entire portfolios through more central procurement, which gives owners more leverage in negotiations;
  (2) Active asset management initiatives to reduce energy use by installing smart metering systems, interactive heat monitoring and installation of LED lighting;
  (3) Significant capital expense projects such as wall and roof insulation, double glazing, solar panel installation and M&E services upgrades.

ABOUT AEW

AEW is one of the world's largest real estate asset managers, with €69.5bn of assets under management as at 31 December 2019. AEW has over 700 employees, with its main offices located in Boston, London, Paris and Hong Kong and offers a wide range of real estate investment products including comingled funds, separate accounts and securities mandates across the full spectrum of investment strategies. AEW represents the real estate asset management platform of Natixis Investment Managers, one of the largest asset managers in the world.

As at 31 December 2019, AEW managed €33.0bn of real estate assets in Europe on behalf of a number of funds and separate accounts. AEW has over 400 employees based in 9 offices across Europe and has a long track record of successfully implementing core, value-add and opportunistic investment strategies on behalf of its clients. In the last five years, AEW has invested and divested a total volume of over €20bn of real estate across European markets.

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