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Help from outer space – how to solve the green data challenge

Satellite imagery can support ESG implementation, smart lending, and risk management at financial institutions

analytical. quantitative. tech.

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The implementation of the EU taxonomy in the credit business as well as climate-related credit risk management require a plethora of new data points which are hardly available in financial institutions at the moment. In particular in the real estate mortgage business, access to crucial data points like the energy efficiency of buildings or precise flooding risk assessment is key for compliance with the EU taxonomy, reducing risks, but also for transitioning the financed real estate portfolio to net-zero emissions. In this real-life case study we show how to solve one of the data challenges in an efficient and effective manner by tapping into the potential provided by new data services derived from satellite imagery and large-scale satellite constellations, which are currently growing in low earth orbit.

01.

The use case: tracking carbon intensity in a loan portfolio

A growing number of financial institutions adopt stringent net-zero targets to decarbonize their financed portfolios and loan books until 2050. Additionally, climate change creates new risks for the lending business. Last but not least, current and future regulatory requirements need to be considered. To meet defined targets, manage the risks appropriately, and stay compliant, financial institutions need to consider information which has not been in their specific focus so far. With the aid of practical examples, this paper outlines what institutions require in terms of data and highlights new ways of integrating that data efficiently.

For example, institutions with large retail mortgage portfolios that commit themselves to reducing their carbon footprint need to be aware of key indicators that support tracking compliance with internal and external climate targets on portfolio level. The minimum set of relevant building-related indicators are typically part of their energy performance certificates (EPC), in particular

- Specific energy consumption as measured in kWh/m², and
- Specific greenhouse gas emissions as measured in kg CO_2e/m².

Most conveniently, energy performance and energy-related emissions of the financed buildings in the portfolio may be monitored and checked against current targets in a dedicated dashboard (see Figure 1, blue and green lines).

Ideally, the required EPC data should be available on the spot from central databases set up by governmental authorities, as recommended by the EPBD,[1] but only in 11 of 27 EU Member States EPCs must be uploaded to a central database as a prerequisite to be officially approved.[2] Still, data quality issues are prevalent even in those countries with a majority of EPCs being in a provisional state, for instance. Another concern is the lack of frequency and timeliness of EPC data updates although renovations and other modifications are likely to change the energy characteristics of buildings. Third-party ESG data providers are well established in the large corporate sector, but less so in the small and medium enterprise, retail and real estate segments.

The European Central Bank's climate stress test has triggered a flurry of activities at banks to collect and analyze EPCs for their loan portfolios, but the approaches range from bottom-up data collections to model-based approximations. From a business and cost perspective, bottom-up data collections, which involve con-

1 Energy Performance of Buildings Directive 2010/31/EU.

2 https://ec.europa.eu/energy/eu-buildings-factsheets-topics-tree/energy-performance-certificates_en

tacting clients and asking for their support of this process, are the least desirable approach. In the long run, such data collections will be included in the loan origination process, but the issue of low update frequencies will probably remain.

Nevertheless, EPCs are one of the cornerstones for the implementation of the EU taxonomy, ESG risk management as well as the integration of ESG topics into loan origination and monitoring processes.[3] More specifically, there are at least four use cases for EPCs at financial institutions in the (retail) mortgage sector:

1. EPC data is used to monitor and track climate relevant indicators.

2. EPC information can be used in risk models as studies have demonstrated that green mortgages can be less risky,[4] hence allowing for the adaption of financing conditions for energy-efficient houses.

3. From a regulatory point of view, EPC data will be required in the future and used in regulatory stress tests for banks, such as the climate stress test in 2022.

4. Climate indicators need to be simulated in scenarios to support and challenge the current business strategy.

EPCs are of course only one single data point in the overall universe of additional data required for a fully-fledged ESG implementation. In the context of this paper, EPCs serve as a showcase on how certain issues can be tackled in an efficient, effective, and technologically sound approach.

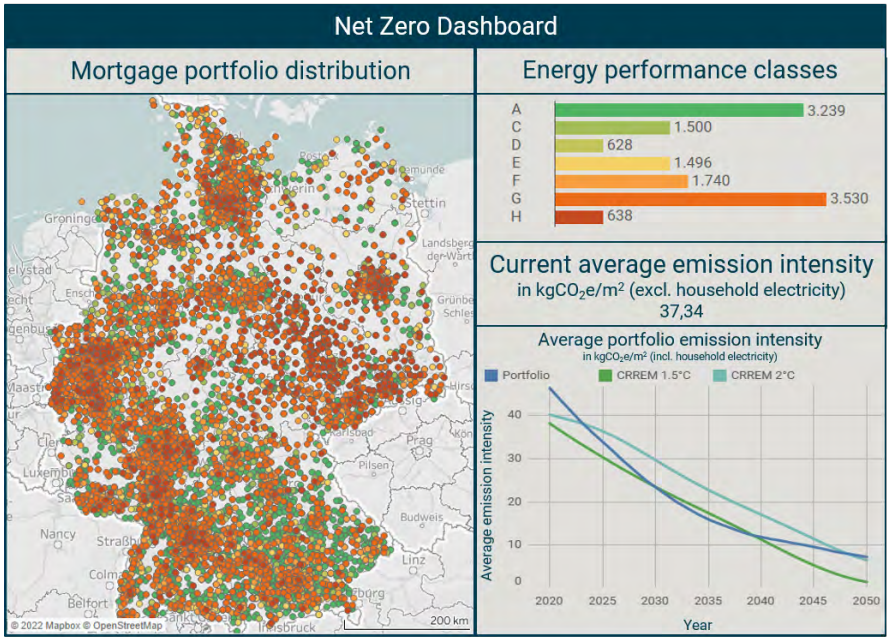


Figure 1: Sample dashboard to display simulated portfolio-level and regional strategies for decarbonizing a mortgage portfolio

3 EBA/GL/2020/06

4 https://ec.europa.eu/eefig/eefig-working-group-risk-assessment_en

02.

Input from outer space: new data sources made practical

Banks and other financial institutions are traditionally not at the forefront of using satellite intelligence in their business. Lending, for example, relies to a large extent on structured financial data of clients, ranging from balance sheet information of corporates to the household incomes of private individuals. This data is typically digested and made available by data service providers like the well-known rating companies.

Climate change and its direct impact on the business of financial institutions, for example via physical and transition risks, prompt the urgent need for additional information beyond classical financial and economic data. Physical risks like flooding can severely impact the value of collateral pledged for loans, in particular in a scenario with insurance contracts not being available anymore in certain areas. Assessment of physical risks can be well supported by timely satellite imagery, as highlighted – for example – during and after the 2021 flooding event in the Ahrtal region, Germany (see Figure 2).

Figure 2: Satellite image showing damaged buildings in the center of Schuld, Germany, after the 2021 flooding event. Source: Planet Team (2022). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. Courtesy of SkenData.

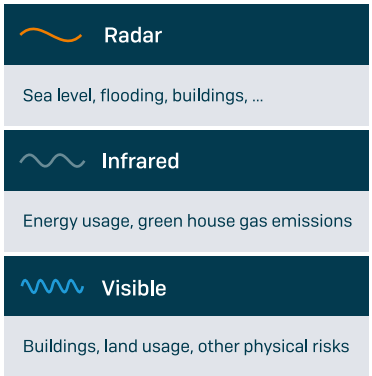


Figure 3: Different wavelengths provide different information

Overall, satellites provide a wealth of timely and information rich raw data which can serve many purposes. Different wavelengths reveal different kinds of terrestrial features (see Figure 3). Satellites in different orbits around earth provide different revisit frequencies for locations on earth, providing e.g. daily noon time updates in sun synchronous orbits. Distance of the orbit from the surface of Earth and optical features of the satellites determine the resolution achieved, which can be as low as 15 cm per pixel. Such resolutions allow algorithms to count cars on parking lots, people at public spaces, ships in harbors, and planes stored in the desert, thereby creating timely economic data. The variety of satellite constellations and satellite data providers allows to select those who are best suited to serve a certain data need.

However, the IT systems of banks are typically not well prepared for ingesting new raw data and satellite imagery and, in particular, geo-information has hardly been in the center of focus at financial institutions so far, with some exceptions at insurance companies. Therefore, identifying the optimal data sources, handling the new data in an efficient manner, and creating the link to the actual banking business is key to tap into the potential of such new data sources for tackling the ESG data challenge. This process can be facilitated by the conceptual framework depicted in Figure 4.

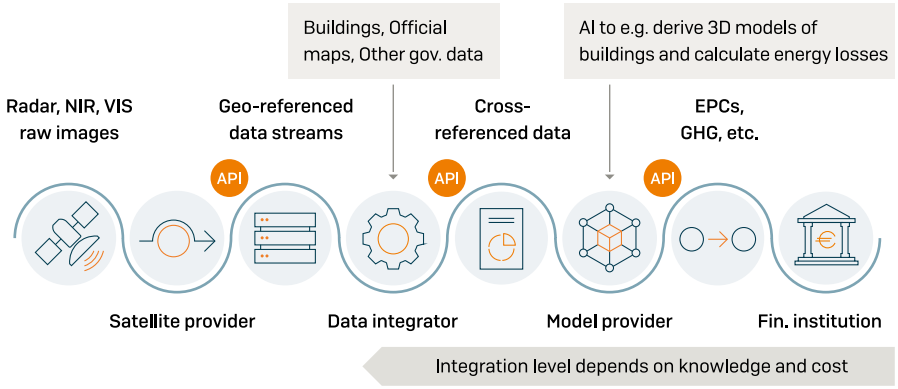


Figure 4: Conceptual framework for the integration of satellite data at financial institutions

Satellite providers launch and maintain satellite constellations in Earth's orbit. They typically provide access to raw, georeferenced data using commercial APIs. However, these data sets are not straightforward to use for non-experts, in particular, when other data streams have to be mapped onto those images. For example, mapping and correct referencing of governmental land databases requires a substantial amount of expertise. This is the market niche where **data integrators** come into play providing enriched data streams to their clients. Even though that layer is already quite accessible to non-experts, e.g. persons responsible for the valuation of buildings and properties, one additional step is yet necessary to deliver the information ultimately required by financial institutions like EPCs, greenhouse gas emissions, flooding risk scores etc. That is why **model providers** use sophisticated artificial intelligence (AI) models to extract information from the data stream provided by data integrators. AI models are not only capable of counting cars on parking lots,[5] but also estimate source specific NOx and carbon emissions.[6,7] There are also companies providing vertically integrated services along that value chain, e.g. by acting as a data integrator or even model provider in addition to more classical satellite services. One example is the change detection provided by Planet Labs via its end-user API.

5 https://storymaps.arcgis.com/stories/0c5acd83794b4a2fad13255eb1c63b47

6 https://www.climatetrace.org/public/papers/2021/ClimateTRACE_BringingRadicalTransparencytoGlobalEmissions_FullReport.pdf

7 https://www.amt.copernicus.org%2Fpreprints%2Famt-2021-177%2Famt-2021-177.pdf

Business model	Provider name
Satellite provider	Airbus (Pléiades Neo constellation) Axelspace CNES (SPOT constellation) Copernicus (Sentinel constellation) GEOSAT Karten Space Maxar Planet Labs Satellite Vu
Data integrator	Airbus Axelspace DHI GRAS European Space Imaging GEOSAT ImmAzing SkenData
Model provider	Airbus DHI GRAS European Space Imaging ImmAzing Pictera Planet Labs RS Metrics Satellite Vu SkenData Sociedad de Tasación

Table 1: Non-exhaustive list of providers of data and notable approaches and services

For financial institutions, it is crucial to integrate this value chain to be able to have adequate skills and resources in-house to perform core elements of their business. For example, if satellite data provides a competitive edge by faster and more reliable updates on the progress of construction projects on a global scale, it might be worthwhile to have that capabilities in-house. Data integration can also involve trusted platforms like EuroDaT[8] for sharing and merging different data streams.

Another important criterion for using certain services is the user friendliness and pricing scheme of their APIs, which also differ substantially between service providers.

8 https://www.eurodat.org/

Infobox: What kind of data is required to estimate energy demand?

Typically, information derived from an energy performance certificate (EPC) is used to assess the energetic performance of a building. These certificates are issued either on the basis of the calculated energy demand or the actually measured energy consumption. However, the latter approach has the disadvantage that it reflects not only the energetic quality of the building itself but also the energy-related behavior of its occupants, which cannot be influenced directly by the real estate industry or in the context of real estate mortgages. If this is the case – or if no data about the energetic performance of a building is available at all – satellite images may help to determine energy demand retrospectively.

In order to be able to calculate the energy performance of the building based on energy demand, it is necessary to break down the building – and in particular 2.5D or 3D models of the building envelope – into its individual elements and to capture the components in terms of area and volume. In addition, information on both construction method and building technology, especially regarding the supply of space heating and domestic hot water, needs to be gathered. Building type, floor area, number of floors or building height, window area, adjacent buildings, photovoltaic installations, etc. can be extracted directly from satellite images. Structural and technical characteristics can be estimated with the help of standardized building typologies and the year of construction. The latter can also be approximated based on statistics, cadaster data and the observed neighborhood context.

All information is consolidated to estimate, for instance, transmission heat losses and the resulting heating demand. By linking the satellite-based observations to the assumed construction method with specified building-related life cycle assessment (LCA) data sets on building materials as well as construction, transport and disposal processes, it is even possible to estimate embodied carbon that arises during the construction phase and in the end-of-life. These emissions will be an increasingly important issue in the future compared to the emissions of the use phase.

In the course of further analyses, aerial photographs are also suitable for assessing the extent to which renewable energy generation can be integrated close to the building, e.g. from geothermal energy, wind power and photovoltaics. In the latter case, roof shape and shading are decisive influence factors which can also be captured by satellite imagery.

In addition to energy balancing and potential analyses, satellite images allow an assessment of a possible vulnerability due to physical climate risks. These can be present on a micro level in the immediate vicinity of buildings (e.g. flooding risk due to neighboring river courses) or prevail on a macro level due to general climatic conditions (e.g. snow, heat, storm or heavy rain).

Against the background of the above-mentioned use cases, satellite-based observation and data analysis offers comprehensive opportunities to provide evidence of compliance with – for example – the technical screening criteria of the EU taxonomy regarding the environmental goals climate change mitigation and adaptation. Both objectives involve specific requirements regarding energy demand or energy efficiency category according to the EPC, require the preparation of a whole life cycle assessment under certain conditions or the performance of a climate risk and vulnerability assessment. Additionally, achieving a global scale and including assets on other continents in GHG emission calculations is another advantage of satellite imagery.

03. A practical example in the real estate mortgage business

Financial institutions, in particular those participating in real estate project finance and mortgage business, are now ramping up their initiatives to collect and analyze data on relevant ESG factors, including the energy performance of financed buildings.

For that reason, the pipeline illustrated in Figure 4 has been applied in a current project to close data gaps in a retail mortgage portfolio and supporting the client in developing a long-term portfolio strategy for the lending business. The project included the development of a business intelligence tool with a dashboard to monitor the specific path towards a net-zero mortgage portfolio (see Figure 1). The client now has the opportunity to simulate different business strategies for the evolution of its portfolio over time and to test whether these strategies are aligned with the pathway for a net-zero retail mortgage portfolio in the next decades.

The initial challenge in the project posed the lack of data on key climate-relevant indicators such as energy performance and emission intensity on building level, since that data has not been collected before in the loan origination process. However, without detailed data for single buildings it is not possible to approximate the climate indicators of the mortgage portfolio with sufficient accuracy to use them for strategy development as well as integration into the asset valuation and lending process.

EPC data is one cornerstone to steer and monitor business strategies for mortgage portfolios.

Missing EPC data is a common problem for financial institutions with mortgage portfolios because there was no (regulatory) necessity to collect this information in the past. This has changed only recently with the ECB's climate stress test and the amended guidelines of the European Banking Authority. It is also not straightforward in terms of cost, time frame, and response rates to collect this data from clients. In particular collecting such data from private individuals and households is prone to data quality issues and lack of coverage.

Typically, the minimum data input is the year of construction and the exact address of the building in order to compute an approximation for building-specific energy and CO_2 emission intensity. If additional information is given, such as details about the heating system or past refurbishments, reliability of the final model results is likely to be enhanced. Ideally, the stock of buildings in a country is already available and processed by the data and model provider, avoiding individual calculations for single assets.

The address is used to locate the building in satellite images. In Figure 4, official cadaster data is mapped to an aerial image of its location by image recognition algorithms that identifies and confirms the state of individual building units. Based on the 2-dimensional outline of the building's footprint, more characteristics are inferred automatically (see Infobox).

The type of heating system cannot be easily inferred from satellite images if this specific information is not available. However, regional statistics based on the building location can be used to determine at least the most probable installed heating system. Combined with the year of construction, it is also possible to approximate the energetic and technical quality of the building materials used for the building envelope, i.e. thermal insulation.

SkenData
Value. Risk. Energy.

The combination of satellite imagery, year of construction and energy-related statistics gives the opportunity to estimate energy performance and CO_2 emission intensity for the whole portfolio. In this project, the data integrator and model provider (SkenData) performed calculations for energy efficiency and emission intensity following generally valid standards based on technical properties of the building but not using regression methods. As a result, the calculations are building-specific, even more so if they make use of information on individual modernizations. Therefore, the calculation results could also be used to create or update official EPCs for retail customers.

Portfolio and asset-level GHG emissions can be approximated efficiently with the help of satellite imagery and suitable building models.

The data on key climate indicators was not only used to measure the status quo but also to simulate climate-relevant decarbonization paths for the complete real estate portfolio in various business scenarios. For a mortgage lender in general, the relevant business planning should be amended by

1. renovation rate of the portfolio,
2. desired renovation depth for existing buildings, and
3. minimum building standards for newly built buildings that enter the portfolio.

Such scenarios were used to challenge and benchmark the current business strategy and to indicate if it is taking the business to where it needs to be in the next 5 to 10 years with respect to benchmark pathways. Benchmark paths being compatible with the Paris agreement are available e.g. at CRREM[9] (Carbon-Risk-Real-Estate-Monitor) on a global or country scale. An exemplary portfolio projection including benchmark paths can be seen in Figure 1 in the bottom right-hand corner.

Figure 5: Buildings are recognized by an image-processing algorithm (Picture courtesy of SkenData ©)

9 https://www.crrem.eu/

04. Lessons learned and conclusions

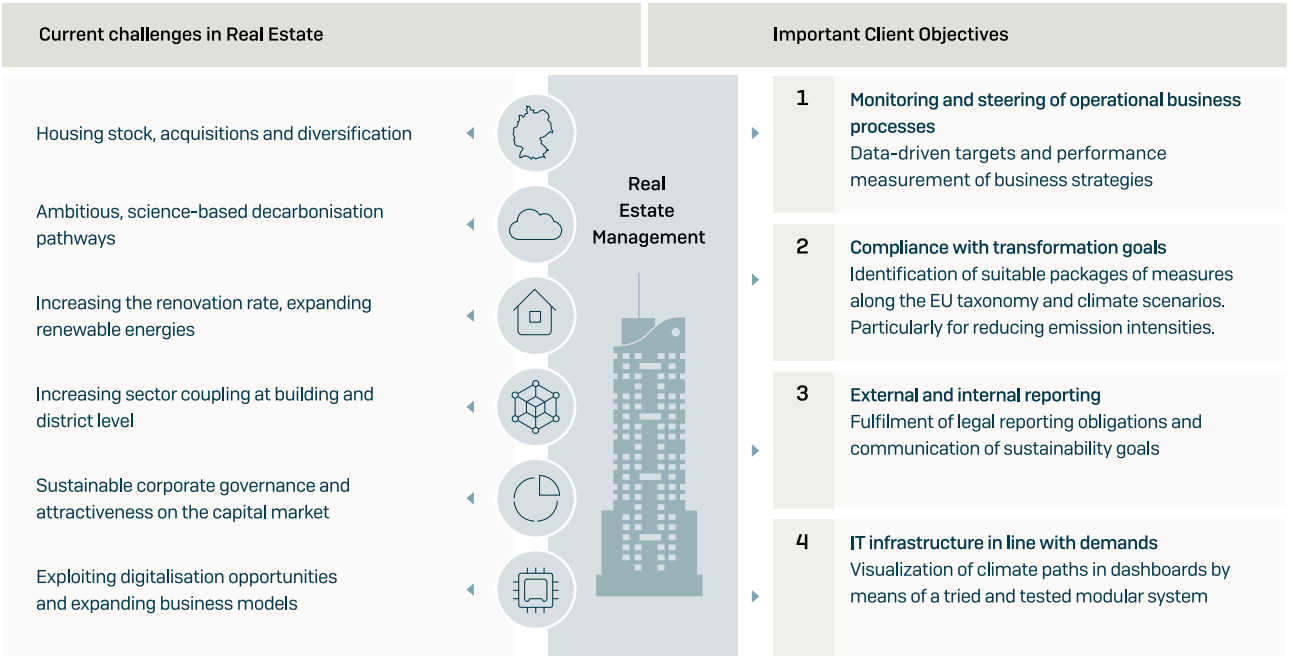
The market in the green lending business is moving very fast, with the pressure felt by many institutions to develop or acquire suitable solutions for filling data gaps and integrating ESG into their front office business processes. Strategic planning now has to cover a vastly prolonged time horizon of decades, which can only be facilitated by new tools. How should an institution approach that challenge?

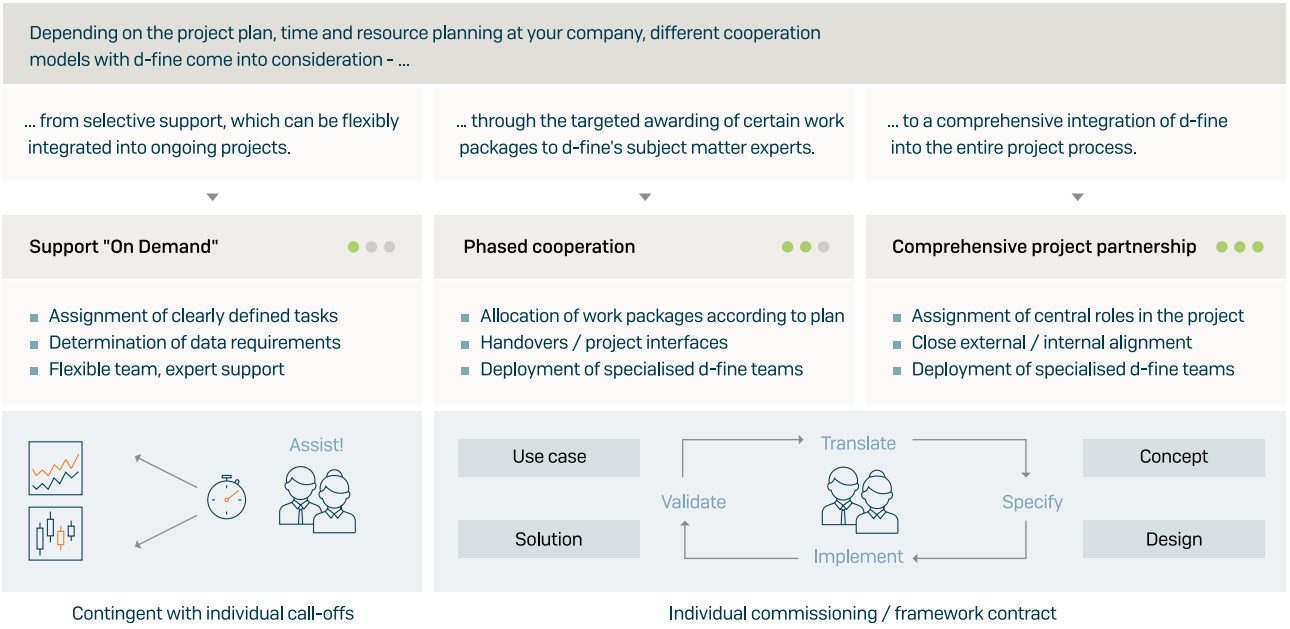
1. Explore, benchmark and challenge different providers: Every organization needs to understand the basics of the tools they are using.
2. Build in-house tools for core business processes, but outsource elements where internal expertise is not differentiating you from your competitors: In some cases, expertise on deep neural networks can drive internal value generation, in some others maybe not.
3. Design your process brick-by-brick: Modern web-based API allow to integrate different internal and external processes seamlessly, given that proper process management tools are in place.

The ecosystem of ESG data providers is developing rapidly, and it might be hard to acquire a reasonable overview. Common standards are either very recent, like EU taxonomy, or still in a development phase. Tapping into this ecosystem with the right partners is likely to provide you with a competitive edge.

05. We support you

The real estate and the real estate financing industry is at the beginning of an ambitious transformation that brings with it challenging and time-consuming adaptions in data collection, management and processing, business strategies and compliance with regulatory reporting standards.





Support from d-fine focuses on your requirements in order to complement existing resources and know-how in a tailor-made manner. Our teams are available for exchange at any time and will be happy to develop an optimized approach that allows you to solve the green data challenge, improve your process efficiency and reduce costs.

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