# Risks and opportunities connected with climate change

**3-3 | 201-2 | TCFD: Strategy and Risk Management**

The process for defining the Group's strategy is accompanied by a careful analysis of the risks and opportunities connected to it, also including the aspects related to climate change. Every year, before the Board of Directors examines the Strategic Plan, the Control and Risk Committee is presented with a quantitative analysis of the risks and opportunities related to the Group's strategic positioning, which includes aspects related to the climate, such as regulatory factors and weather and climate phenomena.

In order to facilitate the proper identification and management of risks and opportunities related to climate change, a **Group policy** was published in 2021 that describes common guidelines for assessing the risks and opportunities arising from climate change. The "Climate change risks and opportunities" policy defines a shared approach for the integration of climate change and energy transition issues into the Group's processes and activities, thus informing industrial and strategic choices to improve business resilience and long-term sustainable value creation, consistent with the adaptation and mitigation strategy. The main steps considered in the policy are as follows:

- **prioritizing phenomena and scenario analysis**. These activities include the identification of physical and transition phenomena relevant to the Group and the consequent development of scenarios to be considered and developed through analysis and processing of data from internal and external sources. Functions can be developed for the phenomena identified that link the scenarios (e.g. data on the change in renewables) to business operations (e.g. the change in potential output);
- **impact assessment**. Includes all analyses and activities necessary to quantify the effects at the operational, economic and financial levels, depending on the processes into which these are integrated (e.g. design of new constructions or operational performance appraisal, etc.);
- **operational and strategic actions**. Information from previous activities is integrated into processes, informing Group decisions and business activities. Examples of activities and processes that benefit are capital allocation, e.g. for evaluating investments on existing assets or new projects; defining resilience plans, risk management and financing activities and engineering and business development activities.

In order to identify the main types of risk and opportunity and their impact on the business associated with them in a structured manner consistent with the TCFD, we have adopted a **framework** that explicitly represents the main relationships between scenario variables and types of risk and opportunity, specifying the strategic and operational approaches to managing them, comprising mitigation and adaptation measures. Two main macro-categories of risks/opportunities are identified:

- those connected with developments in physical variables;
- those connected to the evolution of the transition scenarios.

The physical risks are divided into acute (or extreme events) and chronic: the former are linked to extremely intense weather-climatic conditions, while the latter are linked to gradual and enduring changes in climatic conditions.

Extreme events expose the Group to: potential unavailability of assets and infrastructure for longer or shorter periods of time, service restoration costs, inconvenience for customers, etc. Chronic changes in climatic conditions, on the other hand, expose the Group to other risks or opportunities: for example, structural temperature changes can impact electricity demand and affect generation, while changes in rainfall or wind patterns could impact the Group's business in terms of lower or higher output. Generally speaking, adapting to the changes that will most likely take place in the future also leads to efforts in innovation and strategic positioning: it may be possible to develop new businesses and better products in order to live sustainably in a changed environment.

With regard to the energy transition process, marked by a progressive reduction in $CO_2$ emissions, there are risks and opportunities associated with the changing regulatory and legislative context, with trends in technological and competitive development, with electrification and behavior, and with the resulting market trends.

In line with the climate and transition scenarios that Enel has used to define risks and opportunities, it appears that the main phenomena related to the transition are now becoming evident depending on the behavior adopted by customers, the industrial strategies adopted by various sectors of the economy and regulatory policies, including fiscal policies. By the year 2030, transition trends will be observable as the context evolves: the Enel Group has decided to lead and pave the way for the transition, and is prepared to seize any associated opportunities. As previously mentioned, strategic choices that focus strongly on energy transition, with more than 90% of investments being dedicated to improving some of the SDGs, make it possible to adopt risk mitigation "by design" and to maximize opportunities by maintaining a position that takes into consideration the identified medium and long-term phenomena. Strategic choices go hand in hand with the operational best practices implemented by the Group.

## Framework of main risks and opportunities

| Scenario phenomena | Time horizon | Risk & opportunity driver | Description | Management approach |
|---|---|---|---|---|
| Acute physical | Starting with short term (1-3 years) | Extreme events | **Risk**: especially extreme weather/climate events, which can damage assets and interrupt operations. | The Group adopts best practices to manage the restoration of service as quickly as possible. We also work to implement investments in resilience (e.g., the Italian case). With regard to risk assessment in insurance, the Group has a loss prevention program for property risk that also assesses the main exposures to natural events, supported by preventive maintenance activities and internal risk management policies.<br>Looking forward, the assessments will also include the potential impacts of long-term trends in the most significant climate variables. |
| Chronic physical | Starting with long term (2030-2050) | Market | **Risk/opportunity**: increase or decrease in electricity demand under influence of temperature, whose variations can impact the business. Increase or decrease in renewables output, which may be affected by structural changes in resource availability. | The Group's geographical and technological diversification means that the impact of changes (positive and negative) in a single variable is mitigated at the global level. In order to ensure that operations always take account of weather and climate phenomena, the Group adopts a range of practices such as, for example, weather forecasting, real-time monitoring of plants and long-term climate scenarios to identify any chronic changes in renewable source availability. |
| Transition | Starting with short term (1-3 years) | Policy & Regulation | **Risk/opportunity**: policies on $CO_2$ prices and emissions, energy transition incentives and policies, revision of market design and permitting procedures, and resilience regulation. | The Group is minimizing its exposure to risks through progressive decarbonization and the focus of the business on renewables, grids and customers. The business model is designed to maximize the benefits of our integrated position in the core countries and leveraging stewardship activities, which enables us to exploit the opportunities connected with the energy transition. The Group is also actively contributing to the formation of public policies through its advocacy efforts. These activities are conducted within platforms for dialogue with stakeholders that explore ambitious national decarbonization scenarios in the various countries in which Enel operates. |
| Transition | Starting with medium term (2022-2030) | Market | **Risk/opportunity**: changes in the prices of commodities and energy, evolution of energy mix, changes in retail consumption, changes in competitive environment. | The Group is maximizing opportunities by adopting a strategy founded on the energy transition, focusing on the electrification of energy consumption and the development of renewables and a geographical positioning in countries in which we have an integrated presence. Considering alternative transition scenarios, the Group assesses the impact of different commodity price trends, changes in the share of renewables in the generation mix and the electrification of final consumption. |
| Transition | Starting with medium term (2022-2030) | Product and Services | **Opportunity**: increase in margins and greater scope for investment as a consequence of the transition in terms of greater penetration of electrical mobility, distributed generation and new technologies for the direct and indirect electrification of final consumption. | The Group is maximizing opportunities thanks to its strong positioning in new businesses and beyond-commodity services. In addition, considering alternative transition scenarios, the Group assesses the impact of different trends in the electrification of consumption. |
| | Starting with medium term (2022-2030) | Technology | | The Group is maximizing opportunities thanks to its strong strategic positioning in new businesses and global grids. With the penetration of direct and indirect electrification technologies, considering alternative scenarios, the Group assesses the potential opportunities for scaling existing and potential businesses and for the development of new solutions linked to digitalization and resilience of power grids. |

The framework outlined above also highlights the relationships that link the physical and transition scenarios with the potential impact on the Group's business. These effects can be assessed over three time horizons: the short-medium term (1-3 years), in which sensitivity analyses based on the Strategic Plan presented to investors in 2022 can be performed; medium-term (until 2029), in which it is possible to assess the effects of the energy transition; and long-term (2030-2050), in which chronic structural changes in the climate should begin to emerge.

The following will describe the main sources of risks and opportunities identified, operational best practices for managing weather and climate phenomena, and qualitative and quantitative impact assessments conducted to date. All of the above activities are performed throughout the year through an ongoing effort to analyze, evaluate and manage the information processed. As TCFD states, the process of disclosing risks and opportunities related to climate change will be gradual and incremental from year to year.

## Transition phenomena: business effects, risks and opportunities

As regards the risks and opportunities associated with transition variables, we consider the different reference scenarios in combination with the elements that make up the risk identification process (e.g. competitive context, long-term vision of the industry, materiality analysis, technological evolution etc.) to identify the drivers of potential risks and opportunities, with priority on events with greater relevancy. The main identified risks and opportunities are described below.

### Policy and Regulation

- **Limits on emissions and carbon pricing**: the enactment of laws and regulations that introduce more stringent emissions limits by government action (non-market driven) and market-based mechanisms.
  - **Opportunities**: Command & Control regulations and market-based mechanisms strengthening $CO_2$ price signals to foster investment in carbon-free technologies.
  - **Risks**: lack of a coordinated approach among the various actors and policy-makers involved and limited effectiveness of the policy instruments deployed, with an impact on the speed of the trend toward electrification and decarbonization in the various sectors, compared with a decisive group strategy focused on the energy transition.

- **Policies and regulation to accelerate the energy transition and energy security**: introducing policies, regulatory frameworks and market design revisions that promote the energy transition, consequently guiding the energy system toward the use of renewable energy sources as the mainstream approach in the energy mixes of countries, greater consumer electrification, energy efficiency, flexibility of the electrical system and upgrading of infrastructure.
  - **Opportunities**: creating a more favorable framework for investing in renewables, also through the development of long-term markets (PPAs, CfDs), electrical technologies and distribution networks in line with the Group's strategy.
  - **Risks**: lengthy administrative authorization processes and ineffective market design and regulatory frameworks in core countries can lead to reduced asset profitability and limited opportunities for growth.

- **Resilience regulation and adaptation**: improvement of standards or introduction of *ad hoc* mechanisms to regulate investments in resilience in the context of the evolution of climate change.
  - **Opportunities**: benefits from investments that reduce service quality and continuity risks for the community.
  - **Risks**: in the case of especially severe extreme events with a greater-than-expected impact, there is a risk of failure to recover within an adequate timeframe and consequently a risk to Enel's reputation.

- **Financial measures for the energy transition**: developing policies and financial instruments that promote the energy transition, which should be capable of supporting an investment framework and a long-term, credible and stable positioning of policy-makers. Introduction of rules and/or public and private financial instruments (e.g. funds, mechanisms, taxonomies, benchmarks) aimed at integrating sustainability into financial markets and public finance instruments.

- **Opportunities**: the creation of new markets and sustainable finance products consistent with the investment framework, activating greater public resources for decarbonization and access to financial resources in line with energy transition objectives and the related impact on costs and on finance charges; introduction of subsidized support tools (funds and calls) for the transition.
- **Risks**: actions and instruments not sufficient to provide incentives consistent with an overall positioning tailored to the energy transition, uncertainty or slowdown in the introduction of new instruments and rules due to the deterioration in finances.

## Market

- **Commodity price dynamics**: changes in market dynamics, such as those relating to commodity price volatility, may influence the behavior of traders, policy makers and customers.
  - **Opportunities**: accelerating clean electrification as a solution for cutting energy costs and limiting exposure to commodity volatility. Customers are more likely to switch from conventional fossil-fuel technologies to efficient electrical technologies.
  - **Risks**: a "disorderly" energy transition due to the introduction of potentially distortive measures.
- **Market dynamics**: end users are more likely to choose more sustainable technologies as they are more aware of climate change risks and due to greater regulatory pressure.
  - **Opportunities**: positive effects associated with the growth in electricity demand and the greater room for renewables, also thanks to an increased demand for long-term contracts (PPAs).

## Technology

- **Technology penetration to support the transition**: gradual penetration of new technologies such as storage, demand response and green hydrogen; digital lever for transforming operating models and "platform" business models.
  - **Opportunities**: investments in the development of technology solutions, as well as positive impacts from increased electricity demand and increased room for renewables from green hydrogen generation.
  - **Risks**: slowdowns and interruptions to the raw materials supply chain, including metals for batteries (such as lithium, nickel and cobalt) and semiconductors, could lead to delays in procurement and/or increased costs, such as to slow down the penetration of renewables, storage and electric vehicles.

## Products and services

- **Electrification of residential consumption and industrial processes**: with the gradual electrification of end uses, the penetration of products with lower costs and a smaller impact in terms of residential emissions will expand (for example, the use of heat pumps for heating and cooling).
  - **Opportunities**: increase in electrical consumption in the context of reducing energy consumption, thanks to the improved efficiency of the electric carrier. More opportunities to provide beyond commodity services and the chance of reducing the energy expenditure and carbon footprint of customers. Increasing investment in networks to drive consumer electrification.
  - **Risks**: additional competition in this market segment. This phenomenon depends on whether electricity networks are well developed, which is crucial for ensuring increasing load levels and service continuity.

- **Electric mobility**: use of more efficient and effective modes of transportation from the point of view of climate change, with a special focus on the development of electric mobility and charging infrastructure; electrification of large-scale industrial consumers.
  - **Opportunities**: positive effects of the increase in electricity demand and greater margins connected with the penetration of electric transportation and the relative beyond commodity services.
  - **Risks**: additional competition in this market segment.

The Group has already implemented strategic actions to mitigate the potential risks and exploit the opportunities associated with transition variables. Shared long-term value can be created through an industrial and financial strategy that incorporates ESG factors, with an integrated approach focusing on sustainability and innovation.
The strategy focusing on full decarbonization and energy transition enables the Group to be resilient to risks resulting from the introduction of more ambitious policies for reducing emissions. It also maximizes opportunities for developing renewable generation, infrastructure and enabling technologies, partly through geographic positioning in countries with an integrated presence and by promoting stewardship activities.

To quantify the risks and opportunities deriving from the energy transition in the long term, two transition scenarios, described in the paragraph "Energy transition scenarios". The effects of Slower Transition and Accelerated Transition scenarios have therefore been identified on the variables that can have the greatest impact on the business, in particular electricity demand, influenced by the dynamics of consumer electrification, and therefore of penetration of electrical technologies and the electricity generation mix. These considerations offer a basis for determining the Group's strategic positioning in terms of resource allocation.

Enel's reference scenario – the Paris scenario – entails a growing ambition in terms of decarbonization and energy efficiency, supported by greater electrification of final energy consumption and the development of renewable capacity. The dynamics related to the energy transition will bring increasing opportunities to the Group. In particular, in the retail electricity market, progressive electrification of final energy consumption – especially for transport and the residential sector – will lead to a considerable increase in electrical consumption to the detriment of other, more high-emissions energy carriers. Similarly, the gradual increase in the proportion of renewable energy in the energy mix is expected to lead to a reduction in the wholesale price of electricity in the medium to long term. However, this impact is limited, given that the market design based on the system marginal price is unchanged in the medium term. Possible alternative market structures could induce different effects.

In reference to the economic impacts that may result from the change in the transition scenarios, the Group has performed some analyses regarding impacts in terms of EBITDA that the Slower Transition and Accelerated Transition scenarios would bring to the 2030 results compared to the baseline Paris scenario.

With reference to consumer electrification, the Slower Transition scenario encompasses lower penetration rates of the most efficient electrical technologies, in particular electric cars and heat pumps, causing a decrease in electricity demand compared to the Paris scenario, which is estimated to cause limited impacts on the Retail commodity business & beyond. At the same time, lower electricity demand results in less development space for renewable capacity, with impacts on the generation business.

With reference to the Accelerated scenario, a more rapid reduction in the cost of green hydrogen generation technologies is assumed. This results in a higher penetration of this energy carrier, at the expense of blue and gray hydrogen, with a consequent additional effect on domestic electricity demand and renewable capacity installations compared to the Paris scenario.

For the different countries and regions, all scenarios, but to a greater extent the Paris and Accelerated scenarios, will involve a considerable increase in the complexities that will have to be managed by the grids. A significant increase is expected in fact in distributed generation and in other resources, such as storage systems, greater penetration of electric mobility with the relative charging infrastructures, as well as the increasing rate of electrification of consumption and the introduction of new actors with new methods of consumption. This context will involve a decentralization of the extraction/feed-in points, an increase in electric demand and the average requested power, a considerable variation in energy flows, which will require dynamic and flexible grid management. The Group therefore expects that in this scenario incremental investments will be necessary to guarantee the connections and suitable levels of quality and resilience, by promoting the adoption of innovative operating models. These investments must be accompanied by coherent policy and regulation scenarios to guarantee suitable economic returns for the Enel Grids Business Line.

**Time horizon**

Short (2022-2024)
Medium (until 2030)
Long (2030-2050)

Upside Downside

| Category | Time horizon | Main drivers | Scenario | Quantification - range < €100 mn | Quantification - range €100-300 mn | Quantification - range > €300 mn | Mitigation Actions |
|---|---|---|---|---|---|---|---|
| Market | Medium | Electrification trend and unit consumption | **Accelerated**: increase in average unit consumption thanks to greater electrification. It already includes effects connected with greater efficiency. Positive impact from increased revenues, partly offset by rise in sourcing costs | ● | | | |
| | | | **Slower**: decrease in average unit consumption as a result of reduced electrification. Negative impact linked to decrease in revenues, partly offset by decline in sourcing costs | | ● | | *Adoption of measures to increase CB in order to offset negative margins* |
| Products and Services | Medium | Green hydrogen development scenarios | **Accelerated**: impacts connected to increased volumes associated with an expansion of indirect penetration of electrification through green hydrogen (with potential increase in growth capacity) | | ● | | |
| | | | **Slower**: impacts connected to decreased volumes associated with reduction in indirect penetration of electrification through green hydrogen | ● | | | |
| Products and Services | Medium | Development of electric mobility/ photovoltaics | **Accelerated**: change in margins as a function of greater penetration of EV and distributed generation | ● | | | |
| | | | **Slower**: change in margins as a function of decreased penetration of EV and distributed generation | | ● | | *Mitigation in strategy of offering "packages" of services* |

Note: The estimated transition impacts are based on current coverage levels.

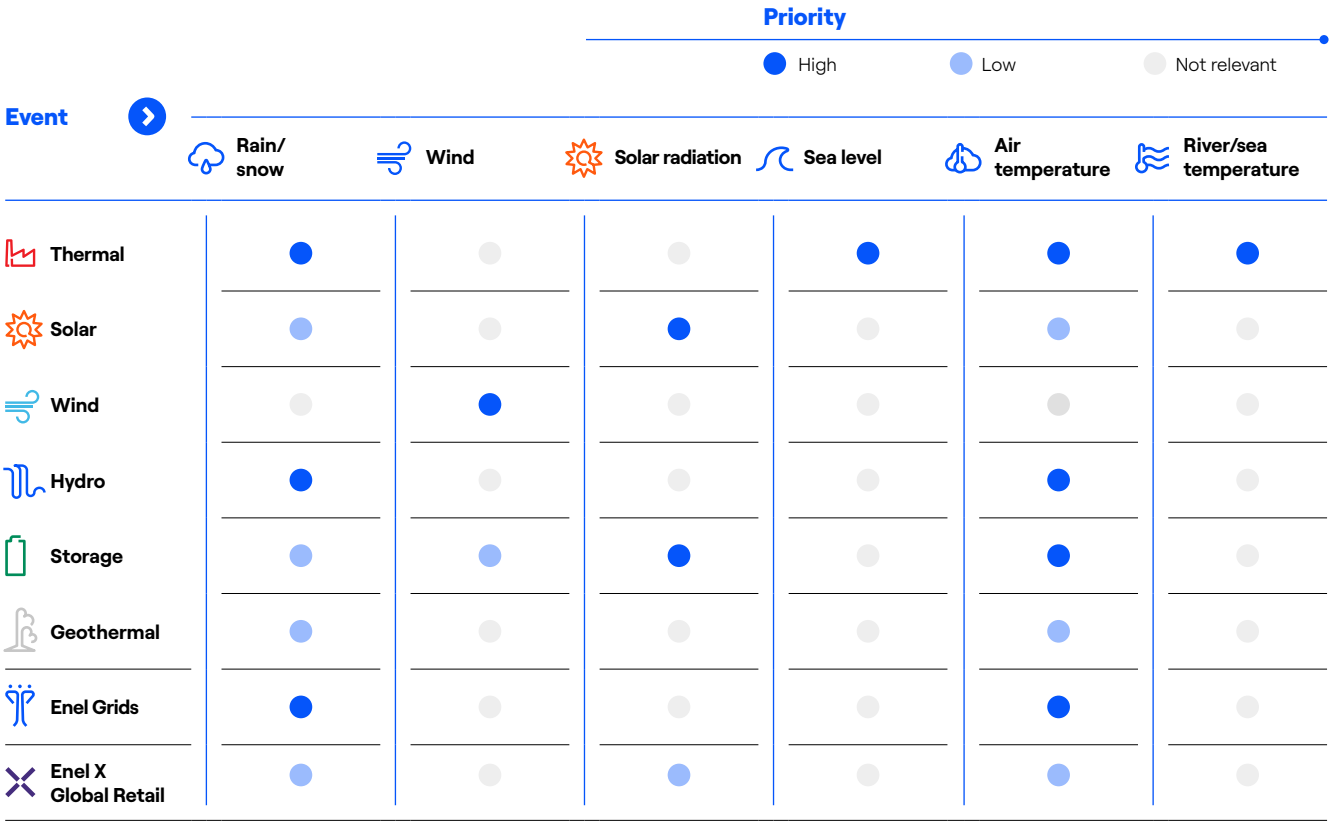
# Physical phenomena: identification, assessment and management of risks and opportunities

## Chronic physical risks

The climate scenarios jointly developed with the International Centre for Theoretical Physics in Trieste, Italy, do not show any certainty of structural changes before 2030, while some structural changes may begin to take place between 2030 and 2050. Basically, even though weather changes are being recorded, which are often significant, it is nevertheless difficult to determine in the short term whether certain phenomena are changing structurally, that is, whether average reference values are already changing. This can be established in the long run with probability intervals.
The main impacts of chronic physical changes can produce similar effects on the following variables:

- **electricity demand**: variation in the average temperature level with a potential increase or reduction in electricity demand;
- **thermal generation**: variation in the level and average temperatures of the oceans and rivers, with effects on thermal generation;
- **hydroelectric generation**: variation in the average level of rainfall and snowfall and temperatures with a potential increase and/or reduction in hydroelectric generation;
- **solar generation**: variation in the average level of solar radiation, temperature and rainfall with a potential increase or reduction in solar generation;
- **wind generation**: variation in the average wind level with a potential increase or reduction in wind generation.

The Group is working to estimate the relationships between changes in physical variables and the change in the potential output of individual plants in the different categories of generation technology.
As part of the assessment of the effects of long-term climate change, chronic events relevant to each technology were identified and analyses of their impacts on manufacturability were initiated.



**The initial scenario analysis has shown that chronic structural changes in the recent trends of physical variables will begin to occur in a considerable manner starting from 2030**. However, in order to obtain an indicative estimate of the potential impacts, and include the possibility of the early onset of chronic effects, it is possible to test sensitivity of the Industrial Plan to the factors potentially influenced by the physical scenario, regardless of any direct relationship with climate variables. The existing Industrial Plan was created based on the information contained in the average scenarios for chronic phenomena, so that the possible effects of trends in climatic variables could also be taken into consideration.

## Analyses of the impact of chronic climate change on renewable generation

A number of *ad hoc* functions were created for each renewable technology (wind, solar and hydroelectric) and plant in order to calculate the impact of the chronic effects of climate change on the generation of our assets. For each variation in climate variables (such as temperature, radiation, wind speed and rainfall), these functions associate likely changes in the electrical output of the plants in our portfolio.

The first step in calibrating these "link" functions was to use the historical data of the weather-climate variables and the internal references of the observed energy output of our plant fleet. This allowed us to obtain "link" functions that meet the specific characteristics of each renewable plant and technology.

As a result, we were able to study the chronic climate impacts for possible future forecasts of climate variables (RCP 2.6, 4.5 and 8.5 scenarios).

In addition to chronic phenomena involving average structural changes, it is also important to study the volatility that is characteristic of weather and, consequently, more short-term. Information obtained from the ranges of variation of chronic trends predicted by climate scenarios was taken as input for strategic planning, as was the historical volatility of meteorological data by analyzing variations in electricity generation (TWh) over the last 10 years.

Weather and climate fluctuations can lead to adjustments, since the output of power plants feeds sourcing for selling energy to customers. This means that reductions in the amount of energy used for renewable generation may lead to sourcing imbalances, which may result in missing volumes being purchased on the market in order to drive the business strategy. On the other hand, increased generation from renewable sources may lead to reduced purchases of volumes on the market (or even more sales).

Based on the analyses conducted at each plant, which were then aggregated, it was calculated that, on average, hydroelectric generation may slightly decrease in the future (with substantial differences between sites), with average variations at country level ranging between -1% and -5% in the 2030-2050 period in the RCP 2.6 scenario compared to historical values. The average changes in wind power output will largely depend on the location of the assets, with minor variations that can be either positive or negative. Ultimately, the effects for solar technology will be mostly positive, with average increases at a country level of up to 3% in the 2030-2050 period in the RCP 2.6 scenario. Such effects, aggregated at portfolio level, highlight the fact that the geographical and technological diversification plays a role in balancing the different variations.

## Acute physical risks

With regard to acute physical phenomena (extreme events), their intensity and frequency can cause significant and unexpected physical damage to assets and generate negative externalities associated with the interruption of service.

Within the scope of scenarios regarding climate change, the acute physical component continues playing an extremely important role when defining the risks to which the Group is exposed, both due to the wide geographical diversification of its asset portfolio and due to the primary importance of the renewable natural resources for the generation of electricity.

In the various cases, the acute physical phenomena such as wind storms, floods, heat waves, severe cold, etc., demonstrate a high level of intensity yet do not have a very high occurrence frequency in the short term, but, considering the medium and long-term climatic scenarios, this will increase considerably in the future.

Hence, for the reasons described above, the Group is currently managing the risk deriving from extreme events in the short term. At the same time, it is extending its methodology also to longer time periods (until 2050) according to the identified climate change scenarios (RCP 8.5, 4.5 and 2.6).

## Methodology for evaluating the risk of extreme events

In order to quantify the risk deriving from extreme events, the Group refers to a consolidated methodology for analyzing the catastrophic risk used in the insurance sector and in IPCC reports[11] Through its own insurance business units and the captive insurance company Enel Insurance NV, the Group is managing the various phases connected to risks deriving from natural catastrophes: from the assessment and quantification to the corresponding coverages to minimize the impacts. The methodology applies to all extreme events that can be analyzed, such as wind storms, heat waves, tropical cyclones, floods, etc. In all of these types of natural catastrophes, however, three independent factors can be identified that are summarized below.

- The **probability of the event ("hazard")**, that is, its theoretical frequency over a specific period of time: the "return time". In other words, a catastrophic event that has a return time of 250 years, for example, implies that it can be associated with a probability of 0.4% that it will occur in a year. This information, which is necessary for assessing the frequency of the event, is then associated with its geographical distribution with respect to the various areas where portfolio assets are located.

- Therefore, for this purpose, the Group uses "hazard maps" which associate, for the various types of natural catastrophes, each geographical points on the global map with the corresponding estimate of the frequency associated with the extreme event. This information, which is organized in geo-referenced databases, is provided by global reinsurance companies, meteorological consultancy companies or academic institutions.

- The **vulnerability**, that, in percentage terms, indicates how much value is lost and/or damaged upon occurrence of the catastrophic event. In more specific terms, therefore, it is possible to refer to the damage to the material assets the impact on the continuity of generation and/or distribution of electricity, and also the provision of the electric services offered to the end user.

- The Group creates and promotes specific vulnerability analyses, especially in the case of damage to its assets, related to every technology in its portfolio: solar, wind and hydroelectric power plants, transmission and distribution networks, primary and secondary substations, etc. These analyses are then, of course, focused on the extreme events that have greater impact on the various types of technology: as a result, this defines a matrix that associates the individual natural catastrophic events with the corresponding type of asset that is impacted in a considerable manner.

- The **exposure**, which is the set of economic values in the Group portfolio that can be considerably impacted by the occurrence of natural catastrophic events. Also in this case, the scopes of the analyses are specific to the various generation technologies, for network assets and for the services to the end user.

The combination of the three factors described above (**hazard**, **vulnerability** and **exposure**) provide the fundamental element for assessing the risk deriving from extreme events. From this point of view, the Group differentiates the risk analysis with respect to the climate change scenarios, depending on the specific nature of the various associated time periods. The following table summarizes the scheme adopted for the evaluation of impacts deriving from acute physical phenomena.

| Time horizon | Hazard | Vulnerability | Exposure |
|---|---|---|---|
| Short term (1-3 years) | Hazard maps based on historical data and meteorological models | Vulnerability, being related to the type of extreme event, to the specifics of the damage type and to the technical requirements of the technology under consideration, Vulnerability is essentially independent of time horizons | Group values in the short term |
| Long term (at 2050 and/or 2100) | Hazard maps and specific studies for different IPCC RCP climate scenarios | | Long-term evolution of Group values |

(11) L. Wilson, "Industrial Safety and Risk Management". University of Alberta Press.
T. Bernold. "Industrial Risk Management". Elsevier Science Ltd.
Kumamoto, H. and Henley, E. J., 1996, Probabilistic Risk Assessment And Management For Engineers And Scientists, IEEE Press, ISBN 0-7803100-47.
Nasim Uddin, Alfredo H.S. Ang. (eds.), 2012, Quantitative risk assessment (QRA) for natural hazards, American Society of Civil Engineers CDRM Monograph no. 5
UNISDR, 2011. Global Assessment Report on Disaster Risk Reduction: Revealing Risk, Redefining Development. United Nations International Strategy for Disaster Reduction. Geneva, Switzerland.
Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation - A Special Report of Working Groups I-II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA.

In the case of the vulnerability of assets within the portfolio, a table for the prioritization of the impacts of the main extreme events on the different technologies has been defined in collaboration with the Group's relevant Global Business Lines:

**Priority**

High · Low · Not relevant

| Event | Heat waves | Flooding/ heavy precipitation | Heavy snow/ icing | Hail | Windstorm | Wildfire | Lightning |
|---|---|---|---|---|---|---|---|
| Thermal | High | High | Not relevant | Not relevant | Low | Low | Under assessment |
| Solar | High | High | High | High | High | Low | Under assessment |
| Wind | High | Low | High | Low | High | Low | Under assessment |
| Hydro | Low | High | Low | Not relevant | Low | Not relevant | Low |
| Storage | High | High | Low | Low | High | High | Under assessment |
| Geothermal | Not relevant | Not relevant | Not relevant | Not relevant | Not relevant | Low | Under assessment |
| Enel Grids | High | High | High | Low | High | High | High |
| Enel X Global Retail | High | Low | Low | Low | Low | Low | Under assessment |

## Management of risks from short-term extreme events

Over the short term (1-3 years) the Group, in addition to what was illustrated above in terms of risk assessment and quantification, will implement actions targeted toward reducing the impacts on business due to extreme catastrophic events. It is possible to distinguish two main types of actions: defining an effective insurance coverage and the various climate change adaptation activities related to preventing damage that could result from extreme events. The main components of these actions are described below and, in the case of activities related to preventing and mitigating the damage, specific reference is made to the Group's Generation and Infrastructure and Networks Global Business Lines.

## Impacts of acute physical events on the Group

The Enel Group has a well-diversified portfolio in terms of technologies, country and regional distribution and asset size. Consequently, the exposure of the portfolio to natural risks is also diversified. The Group implements various risk mitigation measures which, as will be described below, include both insurance coverage and other managerial and operational actions aimed at further reducing the Company's risk profile.

Indeed, empirical evidence shows negligible repercussions of such risks, as demonstrated by data for the last 5 years. Considering the most relevant events, defined as those with a gross impact >10 million euros, the cumulative value of the gross impact amounts to ~130 million euros, which represents less than 0.06% of the Group's insured values as of 2022, or ~224 billion euros, most of which are recovered through insurance payouts.

## Enel Group insurances

Every year, the Group defines global insurance programs for its business in the various countries where it operates. The two main programs, in terms of scope of coverage and volumes, are as follows:

- the **Property Program** ("Property Damage and Business Interruption Insurance Program") for material damage that can be caused to the assets and the resulting interruption in business. Therefore, in addition to the cost for the new reconstruction of the asset (or its parts), also the economic losses due to their shutdown in terms of gen-

eration and/or distribution of electricity are also remunerated according to the limits and conditions defined in the policies;

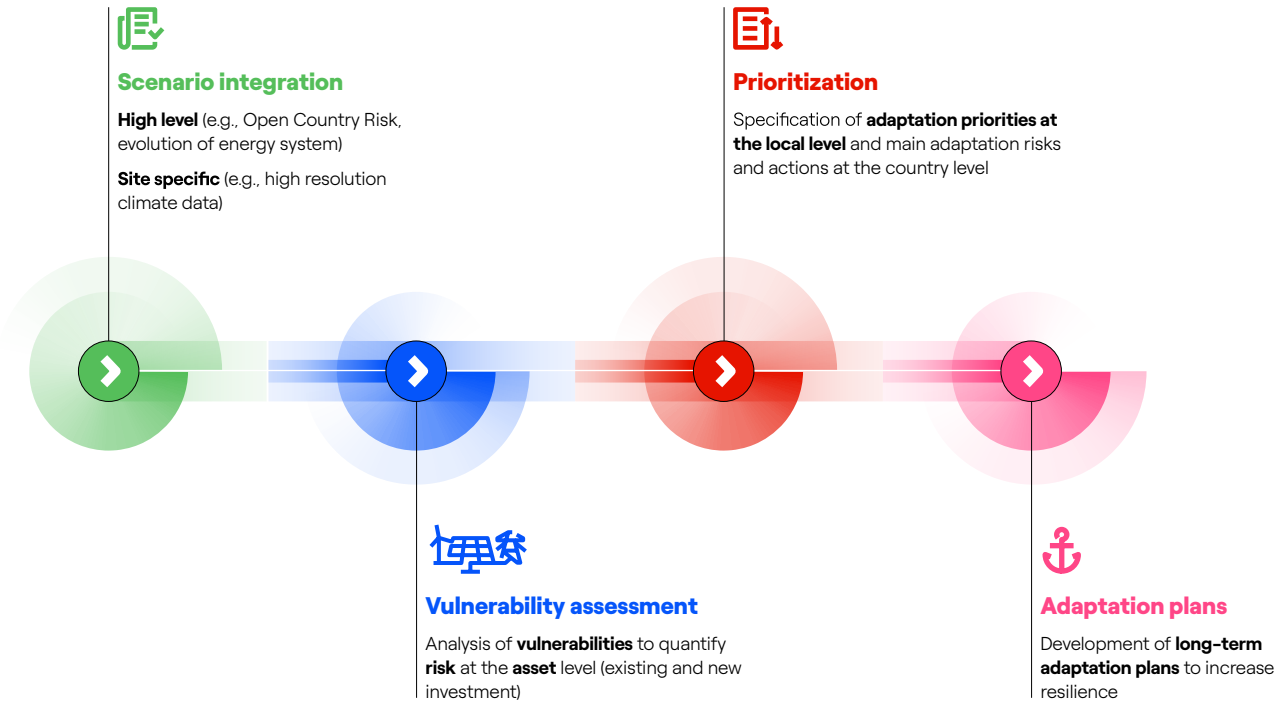
- the **Liability Program** ("General & Environmental Liability Insurance Program"), which covers third party damage following the impacts that extreme events can have on the assets and on the Group's business.

Starting from an effective assessment of the risk, suitable limits and insurance conditions can be defined in the insurance policies and this also applies in the case of natural extreme events related to climate change. In fact, in this latter case, the impacts on business can be considerable but, as shown in cases that occurred in the past and in various areas around the world, the Group has shown absolute resilience thanks to the wide insurance coverage limits, which are also the result of a solid reinsurance structure, as regards the Group's captive company Enel Insurance NV.
In this context of effective insurance coverage, the measures implemented by the Group with regard to the preventive maintenance of electricity generation and network assets are equally important. In fact, while the effects of such activities are directly reflected in the mitigation of the impacts of extreme events, they are also an essential prerequisite for optimizing risk financing and for minimizing – compared to the insurance market – the costs of global hedging programs, including the risk associated with natural catastrophic events. This adaptive strategy consists of managerial strategies and actions, not only related to insurance, which change according to boundary conditions; for instance, the Group was able to substantially reverse the sharp upward trend in premiums in insurance markets by modifying its risk retention policies for assets and by implementing internal risk transfer policies that reward better performing Business Lines when it comes to risk mitigation. From this perspective, the method and information extracted from *ex-post* event analyses play a crucial role in defining processes and practices for mitigating similar events in the future.
As part of the Property Program, Enel Insurance NV envisages a Premium Refund program for Business Lines related to the loss ratio and the achievement of the Group's SDG goals, thereby contributing to the virtuous circle linked to the Group's adaptation to the challenges posed by climate change.

For further information, please read the 2022 Integrated Annual Report.

## Enel's resilience and adaptation to climate change

The application of long-term climate scenarios makes it possible to prepare adaptation plans for the Group's portfolio of assets and activities. Climate scenarios are developed by identifying the physical phenomena that are most relevant to each business (such as heat waves, extreme rainfall, fire risk, etc.) in order to produce analyses that provide not only high-level indications (such as country risk indices that can be compared with each other), which make it possible to study physical impacts at an individual site. This approach applies to both the existing portfolio and to new investments.
By assessing the vulnerability of assets, priority actions to increase resilience can be identified.



# ADAPTATION: a climate-proof future

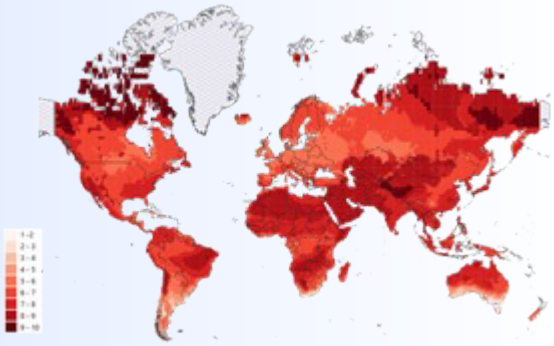
**Mario Ciancarini**

Group Climate Scenarios, Climate Change Adaptation Strategy – AFC Group Strategy

**We are building a climate-proof company, combining mitigation efforts with the ability to understand change and deliver solutions aimed at maintaining profitability and promoting resilient growth models for the benefit of all stakeholders.**

*"Adaptation to climate change is only possible by taking a multidisciplinary approach. At Group Strategy, we work together and exchange views with climate change experts in order to translate the latest knowledge into useful information for the Group. Along with all business lines, we apply instruments and expertise so that we can develop solutions that will increase our resilience, our ability to deal with adverse events and to design products and services that support stakeholders' adaptation."*

**Climate Risk Index**



Since 2018, the Group has been working with the International Center for Theoretical Physics in Trieste to define climate scenarios for the next 30 years and even longer. Since then, we have continued to develop instruments and skills in order to manage, understand and apply a huge amount of data. We now provide the Group with global climate analyses, which are based on data gathered both independently by the scientific community and through partnerships with academic and private institutions and innovation challenges. These analyses look at three different climate scenarios that cover all possible futures.

A project to define a Climate Change Adaptation Plan was launched in 2022, involving staff departments and business lines, with the aim of translating the study of complex physical phenomena and asset vulnerability into tangible actions. The goal is to increase business resilience, enhancing responsiveness to adverse events and seizing opportunities by creating products and services that will benefit customers and all stakeholders. Besides using high-resolution data and carrying out detailed analyses of individual assets, the approach that was adopted enables global climate risk to be assessed by comparing the evolution of several extreme events in the different countries.

For example, one of several results achieved in collaboration with EGP was the calculation of the expected variation in renewable output from hydroelectric, wind and solar plants between 2030 and 2050. A further example is the study, conducted with Enel Grids, which has estimated that breakdowns could potentially increase as a result of increased heat waves in Italy between 2030 and 2050. These works will continue by incorporating more and more Adaptation into all of the Group's processes so that, by working together, we can build a climate-proof future.

## Adaptation activities

The Group implements solutions to climate change adaptation by taking a comprehensive approach, which involves assessing the potential impacts in order to properly target the measures required to improve the ability to respond to adverse events (Response Management) and to increase business resilience (Resiliency Measures), consequently reducing the risk of adverse events having a negative impact in the future. Moreover, the Group will use the expertise and instruments developed to analyze the effects of climate change in order to create value by devising new business options aimed at offering solutions that will make the adaptation process easier for communities and all stakeholders.
Adaptation solutions may concern both actions implemented in short-term and long-term decision making, such as the planning of investments in response to climate phenomena. Adaptation activities also include procedures, policies and best practices.
For new investments, action can also be taken early in the design and construction phase to reduce the impact of climate risks by design, for example by taking into consideration climate scenarios and analyses of the vulnerability of assets to specific phenomena in order to implement resilient solutions.

The following table shows a high-level summary that represents the type of actions that Enel implements for proper management of adverse events and to increase resilience to weather phenomena and their evolution due to climate change. Several activities are described in greater detail below.

| Business Lines | A. Resiliency Measures – Enhancing asset resilience | B. Response Management – Adverse event management |
|---|---|---|
| **Enel Green Power and Thermal Generation** | **Existing assets**<br>1. Guidelines for hydraulic risk assessment and design<br>2. Lessons-learned feedback from O&M to E&C and BD<br><br>**New construction**<br>In addition to actions for existing assets:<br>1. Climate change risk assessments (CCRA) included in environmental impact documentation (pilot) | **Existing assets**<br>1. Critical incident and event management<br>2. Site-specific emergency management plans and procedures<br>3. Specific tools for forecasting imminent extreme events |
| **Enel Grids** | **Existing assets and new construction**<br>1. Guidelines for developing grid resilience enhancement plans (e.g., the "Network Resilience Enhancement Plan" of e-distribuzione) | **Existing assets**<br>1. Strategies and guidelines for Risk Prevention, Readiness, Response and Recovery actions for the distribution grid<br>2. Global guidelines for emergency and critical event management<br>3. Risk prevention and preparation measures for fires involving electrical installations (lines, transformers, etc.) |
| **Enel X Global Retail** | **Existing assets**<br>1. Preliminary analysis of the impacts of medium/long-term climate change | **Existing assets**<br>1. Enel X Critical Event Management |

### Generation assets resilience

With regard to generation, over time the Group has carried out targeted actions on specific sites and established *ad hoc* management activities and processes.
Actions on specific sites in recent years include, for example:

- improving cooling water management systems for certain plants in order to counter the problems caused by the decline in water levels in rivers, such as the Po in Italy.
- installing fogging systems to improve the flow of inlet air and offset the reduction in power output caused by the increase in ambient temperature in CCGTs.
- installing drainage pumps, raising embankments, periodic cleaning of canals and interventions to consolidate land adjacent to plants to prevent landslides in order to mitigate flood risks.
- periodic site-specific reassessment for the hydroelectric plants for flood scenarios using numeric simulations. The processed scenarios are managed with mitigation actions and through interventions on the civil works, dams and intake systems.

The Group adopts several best practices to properly manage the impact of weather events on electricity generation, such as:

- **weather forecasting** both to monitor renewable resource availability and detect extreme events, with warning systems to ensure the protection of people and assets;
- **hydrological simulations, territory surveys** (also using drones), **monitoring of possible vulnerabilities** using digital GIS systems (Geographic Information System) and satellite measurements;
- **advanced monitoring of more than 100,000 parameters** (with more than 160 million historical measurements) detected on dams and hydroelectric civil works;
- **real-time remote monitoring of power plants**;
- **safe rooms in areas exposed** to tornadoes and hurricanes, such as wind plants in Oklahoma, USA;
- **adoption of specific guidelines for carrying out hydrological and hydraulic studies** that are targeted, from the first development phases, toward assessing risks inside the plant and toward the external areas of the plant, with the application of the principle of hydraulic invariance during the design of the draining and mitigation works;
- **check of potential climatic trends for the main project parameters** in order to keep the dimensioning of the systems into account for relevant projects (for example: assessments of the temperature of a cold source to guarantee greater flexibility for cooling the new CCGT) and specific civil works (for example: rainfall assessments for the design of drainage systems in solar plants);
- **estimate of extreme wind speed using updated databases** containing the registers and historical trajectories of hurricanes and tropical storms, with the resulting **selection of the wind turbine technology that is best suited** to the conditions that were found.

In order to be able to promptly react to adverse events, the Group also implements dedicated emergency management procedures with real-time communication protocols, planning and management of all activities to restore operating assets in a short space of time, as well as standard checklists for assessing damage, ensuring that all plants can be put back into service as safely and quickly as possible. One way of minimizing the impacts of climate phenomena is the Lesson Learned feedback process, which is implemented by the technical departments, is governed by the existing operating model and influences future projects.

## Grid assets resilience

In order to deal with extreme climatic events, in the Grids Business Line, the Enel Group has adopted **an approach called "4R"** which, in a dedicated Policy that aims to ensure an innovative strategy for the resilience of distribution networks, defines the measures to be adopted in the phase of preparation for an emergency on the network and to ensure swift restoration of services ex post, i.e. once the climatic events have caused damage to assets and/or disconnections. The 4R strategy is divided into four phases:

1. **Risk Prevention**: includes actions that make it possible to reduce the probability of losing grid elements due to an event and/or to minimize its effects, such as interventions able to increase the robustness of the infrastructure and maintenance operations. When choosing technical solutions to increase resilience, a catalogue is used to determine which is the best way to intervene for each climatic event and geographic area;
2. **Readiness**: comprises all measures that aim to improve the timeliness with which potentially critical events are identified, ensuring coordination with the Civil Protection Department and local officials, as well as to prepare the necessary resources once a grid disconnection has occurred;
3. **Response**: represents the phase for assessing the operating capacity for facing an emergency when an extreme event occurs, which is directly correlated to the ability to mobilize operating resources in the field and the possibility to perform remote controlled operations to restore service via resilient backup connections;
4. **Recovery**: the final phase which has the goal of reconnecting the grid as soon as possible with ordinary operating conditions, in the cases in which an extreme weather event cause interruptions in service in spite of the previously adopted measures for increasing resilience.

Following this approach, the Business Line has prepared various policies **on specific actions** aimed at dealing with the various aspects and risks inherent in Climate Change, in particular:

- **Policy for preparation and recovery during emergencies**: a policy related to the last 3 steps of the 4R approach which indicates the guidelines and measures targeted toward improving the preparation strategies, mitigating the impact of total interruptions and, finally, restoring service to the largest number of customers possible as quickly as possible.

- **Guidelines for the Resilience Plan of the electricity grid**: a dedicated policy has the objective of identifying the extraordinary climatic events with the greatest impact on the grid, assessing specific KPIs of the AS-IS grid and improving them on the basis of proposed actions in order to finally assess their order of priority. This makes it possible to select the actions that, when implemented, minimize the impact on the grid of particularly critical extreme events in a certain area/region. The Policy is therefore set in the first two phases of the 4R approach, suggesting measures regarding Risk Prevention and Readiness. In Italy, this Policy translates into the Resilience Plan that e-distribuzione has prepared every year

since 2017, and which represents and addendum to the Development Plan that includes ad hoc investments over a 3 year period that aim to reduce the impact of extreme events belonging to a certain critical cluster: heat waves, ice loads and wind storms (falling of tall trees). Around 672 million euros were invested in the period 2017-2021 and a further 262 million euros will also be used in the following three years, as explained in the addendum to the 2022-2024 Plan. In the face of these risks, investments have been planned such as the targeted replacement of bare conductors with insulated cable, in some cases the burying of cables, or solutions that provide re-powering routes that are not vulnerable to the above-mentioned phenomena. As in Italy, similar topics are being examined in other countries too, such as Europe and South America, so as to prepare a process for planning ad hoc investments that can increase the resilience of grids to extreme events, while taking into consideration the specific characteristics of each territory.

- **Policy on the prevention and preparation of the risk of fire for electrical installations**: a policy dedicated to fire risk defines an integrated approach to emergency management applied to forest fires, both in cases in which they are started by events exogenous to the networks and in cases, albeit rare, in which they are caused by the networks themselves and, in any case, are potentially dangerous for Enel plants. The document sets out the guidelines to be implemented in the various areas of presence so as to identify areas/plants at risk, define specific prevention measures (such as evaluating specific maintenance plans and any strengthening measures) and, in the event of a fire, to manage the emergency in the best possible way so as to limit its impact and resume the service as quickly as possible.

- **The implementation of systems for weather forecasting, grid monitoring** and assessing the impact of critical climate phenomena on the grid, preparation of operational plans and organization of special exercises. In this regard, it is particularly important to have prior agreements in place for mobilizing extraordinary resources – which are identified beforehand in order to deal with the emergency – whether internal or from contracting companies. For instance, in Italy, besides installing and putting into operation three experimental stations in order to observe and investigate the phenomenon of ice-sleeve formation on MV conductors, IoT sensor trials were conducted for monitoring overhead lines in areas that are particularly exposed to snow and wind (Newman project).

## Inclusion of climate change effects in the evaluation of new projects

Many activities related to the evaluation and implementation of new projects can benefit from climate analyses, both general and site-specific, which the Group is beginning to integrate with those already considered in the evaluation of new projects. For example:

- **Preliminary studies**: in this stage, climate data can offer preliminary screening, through the analysis of specific climate phenomena, such as those shown above in the analysis of physical scenarios, and summary indicators such as the Climate Risk Index, integrated into the Open Country Risk. These data provide a preliminary measure of the most relevant phenomena in the area, among those identified as being of interest for each technology.
- **Estimation of potential output**: climate scenarios will be progressively integrated to allow for an assessment of how climate change will modify the availability of the renewable resource at the specific site. In the preliminary analysis of the impact of chronic climate change on renewable power generation, the approach applied for the moment on a few pilot sites and then scaled to the entire generation portfolio is described.
- **Environmental impact analysis**: the Group has begun to integrate the Climate Change Risk Assessment into the set of documentation produced, which contains a representation of the main physical phenomena and their expected change in the area.
- **Resilient design**: as described above, among the climate change adaptation activities, those aimed at devising resilient assets by design take on great importance. The Group is working to consider progressively analyses based on climate data, for example the increase in frequency and intensity of acute events. These will complement existing analyses based on historical data already in use, in order to increase the resilience of future assets, including any adaptation actions that may be required over the life of the project.