REFERENCE SCENARIO

The geopolitical environment

Global economic developments can have a significant impact on the Group's operations due to their direct effects on GDP growth rates, inflation rates and exchange rates in the countries in which Enel operates. In recent years, the stability of the euro area has been shaken by a number of adverse events, such as the COVID-19 pandemic and the more recent military conflict between Russia and Ukraine. Since the euro-area economies are among the most exposed to the war due to their geographical proximity to the conflict area and their strong dependence on gas imports from Russia, they have been severely impacted both in terms of slower GDP growth and higher inflation. The latter was initially triggered by the exponential increase in energy and commodity prices. Subsequently, the repercussions of the increase in the cost of firm's production factors on the prices of non-energy industrial goods fueled a persistent inflationary environment, one that still represents a risk factor requiring careful monitoring. The increase in inflation has eroded household purchasing power and has weighed on industrial production, particularly in more energy-intensive sectors. The easing of inflationary pressures in the second half of the year in the euro area – similarly to developments in the United States – prompted the European Central Bank to interrupt its series of interest rate increases after September. The greater persistence of core inflation (which excludes the most volatile goods) compared with general inflation, however, represents a source of uncertainty concerning the future path of monetary policy, which if kept restrictive for a longer period time could impact economic activity and monetary policy in the euro area.

The year 2024 will again be marked by geopolitical developments on a global scale. The continuation of the conflict between Russia and Ukraine, the more recent tensions that have emerged in the Middle East, the elections scheduled for 2024 in the European Union, the United States, the United Kingdom, India, Taiwan, Iran and many other countries, could all have a significant impact on the domestic and foreign policies of major global players.

On the budgetary policy front, in December 2023 the finance ministers of the European Union reached an agreement for the reform of the Stability and Growth Pact. The new fiscal rules are characterized by greater simplicity and an emphasis on more readily observable variables, with the aim of improving the effectiveness and credibility of the rules.

On the international trade front, systems of sanctions also remain in place, which can influence trade agreements between countries and industrial policies in various regions. Any introduction of new customs duties or export restrictions could further aggravate current macroeconomic conditions and make the geopolitical situation even more uncertain.

The main risks affecting energy commodities lie in the fragility of the natural gas market in Europe. Although commodity prices have fallen well below the highs recorded in 2022, market equilibria are very tenuous, and disruptions along the value chain, such as the loss of a supply route via the Suez Canal, could drive prices up. This would also have a sharp impact on coal and electricity prices, as these variables are strongly correlated with developments in gas prices. These considerations also hold for the oil market, whose flows also pass through countries close to the conflict areas and are strongly influenced by relations between the United States and the Middle East.

The current geopolitical and macroeconomic context, both in the West and in China, will also continue to influence demand in the industrial metals sector, which was affected last year by the slowdown in global economic growth and prolonged political and military tensions. In particular, in China – the global leader in metals markets – the recovery in demand in 2023 was weaker than analysts and experts had forecast, and future developments continue to depend heavily on the impact of government stimuli, which have not been as effective as expected so far, and on the recovery of demand in Western countries. As regards the metals most closely involved in renewable energy technologies, such as lithium and polysilicon, the recent environment of rapidly and sharply falling prices, undermined by disappointing demand for "green" solutions and a very large increase in the supply of both materials, is eroding the margins of producers, who are struggling to sustain investment in near-term price scenario that does not offer much room for growth.

Macroeconomic environment

The global macroeconomic environment in 2023 was characterized by a general slowdown in the real economy, continuing a downward trend that had already begun in the previous year. After a slowdown in global GDP growth to 3.1% on an annual basis in 2022, following the excellent performance of 6.4% growth recorded in 2021, real growth is expected to be even slower in 2023, at 3%. This decline reflects the lagged and continuing effects of the restrictive monetary policy stances adopted by central banks to counteract high inflationary pressures, the loss of consumer purchasing power, the deterioration in financial and credit conditions, and the decline in trade and investment at a global level. Additionally, the protracted military conflict between Russia and Ukraine, the more recent conflict in the Middle East, volatile US-China relations and the resulting global uncertainty have continued to adversely impact energy, commodity and food markets, slowing the normalization of inflationary pressures on a global scale.

In the United States, the economy performed well above market expectations in the 4th Quarter, with GDP expanding by 3.1% on an annual basis, compared with 2.9% in the 4th Quarter of 2022.

Private consumption spending began to realign with real incomes during the year, as excess savings accumulated during the pandemic continued to decline, especially among low-income households. However, a general easing in the inflationary pressures created by the surge in energy commodity prices in the previous year, a very resilient labor market and strong domestic demand buoyed GDP, which is expected to have grown by 2.5% on an annual basis, up from 1.9% the previous year.

In the euro area, macroeconomic conditions experienced a period of stagnation, dragged down by the restrictive monetary policy stance, the impact of high inflation on consumers' real incomes, weak external demand and industrial weakness. The real economy is expected to have entered a technical recession in the 4th Quarter, with a contraction of 0.1% on a quarterly basis in the last three months of the year confirming that already recorded in the previous period. With regard to inflationary pressures, final consumer good prices began to slow in the last quarter of the year thanks to the restrictive monetary policy stance implemented by the European Central Bank, weak domestic demand and falling energy prices, with inflation at 5.5% year-on-year, down from a peak of 8.4% in 2022.

In Italy, economic activity displayed clear signs of flagging, with GDP expected to grow by 0.7% on an annual basis after the strong rise of 3.9% recorded the previous year. Private consumption has been hit by high inflation, while tighter financial conditions have dragged down investment. Subdued external demand also affected exports. By contrast, consumer prices recorded positive signs, with inflation falling sharply in the last quarter thanks to significant base effects resulting from the moderation of energy prices.

In Spain, the economy performed better than the European average thanks to a strong contribution from services, with GDP expected to grow by 2.4%. After a substantial decline in inflationary pressures in the first half of the year driven by the normalization of energy prices, the second half of the year was characterized by rebound, with average annual inflation standing at 3.4% in 2023, compared with 8.3% in 2022.

In Latin America, inflation slowed in 2023, although the decline differed depending on the country. In Brazil, the economy registered faster-than-expected GDP growth in 2023, expanding by an estimated 2.9% on an annual basis. In the first half of the year, growth was driven by the extraordinary performance of the agricultural sector and by robust domestic demand driven by private consumption. The economy was resilient in the second half, sustained by an increase in exports and modest growth in household consumption, which benefited from more moderate inflation and an improvement in the labor market. Inflation decelerated sharply compared with 2022 (the annual inflation rate came to 4.6% in 2023), reflecting a restrictive monetary policy stance and a decline in energy and service prices.

In Chile, zero growth is expected for GDP in 2023, after the 2.5% growth recorded in 2022. In the first half of the year, the tightening of financial conditions due to the restrictive policy stance adopted by the central bank and the uncertainty connected with the constitutional reform process slowed economic activity. In the second half, however, growth was buoyed by the weakness of global demand and rapid disinflation (the annual inflation rate was 7.7% in 2023, compared with 11.6% in 2022), which prompted the Chilean central bank to cut interest rates by 300 basis points.

In Colombia, economic activity slowed sharply in 2023 compared with the previous year, with GDP growing by an estimated 1.0% on an annual basis, a sharp decline from the 7.3% registered in 2022. Persistent inflation, combined with high interest rates for a prolonged period, adversely impacted demand, accompanied by a slowdown in investment and a decline in exports. Inflation slipped below 10% only in December, posting an annual average of 11.8%. The slow process of disinflation enabled the central bank to reduce interest rates by only 25 basis points at the end of the year.

Peru saw the economy contract by an estimated 0.5% in 2023, after posting growth of 2.7% in 2022. Political and social instability, greater-than-expected climate anomalies associated with El Niño and high food prices due to lower agricultural production generated an especially sharp contraction in economic activity in the first half of the year. The inflation rate was 6.3% in 2023, compared with 7.9% in 2022. This decline prompted the central bank to cut interest rates by 100 basis points in the second half of the year.

In Argentina, 2023 was characterized by a severe economic crisis that led to the devaluation of the Argentine peso and continued hyperinflation. GDP contracted by an estimated 1.2% on an annual basis, while inflation rose to 127.9%. The currency devaluations implemented at the end of 2023, which are intended to foster the country's export competitiveness, and the political uncertainty associated with the presidential elections in October have fueled the inflationary spiral.

%	Inflation		
	2023	**2022**	**Change**
Italy	**6.0**	**8.7**	**(2.7)**
Spain	3.4	8.3	(4.9)
Russia	5.9	13.8	(7.9)
Romania	9.8	12.0	(2.2)
India	5.7	6.7	(1.0)
South Africa	5.9	6.9	(1.0)
Argentina	127.9	70.7	57.2
Brazil	4.6	9.3	(4.7)
Chile	7.7	11.6	(3.9)
Colombia	11.8	10.2	1.6
Mexico	5.6	7.9	(2.3)
Peru	6.3	7.9	(1.6)
United States	4.1	8.0	(3.9)
Canada	3.9	6.8	(2.9)

%	GDP	
	2023	**2022**
Italy	**0.7**	**3.9**
Spain	2.4	5.8
Portugal	2.2	6.8
Greece	2.1	5.7
Argentina	(1.2)	5.0
Romania	2.3	4.6
Russia	3.2	(2.1)
Brazil	2.9	3.1
Chile	-	2.5
Colombia	1.0	7.3
Mexico	3.3	3.9
Peru	(0.5)	2.7
Canada	1.0	3.8
United States	2.5	1.9
South Africa	0.5	1.9

	2023	2022	Change
Euro/US dollar	1.08	1.05	2.86%
Euro/British pound	0.87	0.85	2.35%
Euro/Swiss franc	0.97	1.00	-3.00%
US dollar/Japanese yen	140.58	131.55	6.86%
US dollar/Canadian dollar	1.35	1.30	3.85%
US dollar/Australian dollar	1.51	1.44	4.86%
US dollar/Russian ruble	85.51	69.80	22.51%
US dollar/Argentine peso	295.62	130.87	125.89%
US dollar/Brazilian real	4.99	5.16	-3.29%
US dollar/Chilean peso	840.40	873.60	-3.80%
US dollar/Colombian peso	4,320.20	4,261.77	1.37%
US dollar/Peruvian sol	3.74	3.83	-2.35%
US dollar/Mexican peso	17.74	20.11	-11.79%
US dollar/Turkish lira	23.80	16.58	43.55%
US dollar/Indian rupee	82.60	78.63	5.05%
US dollar/South African rand	18.46	16.37	12.77%

The energy industry

Energy and other commodities in 2023

In 2023, prices on the European gas market registered a strong downward trend, reflecting high levels of storage and decreasing demand. On average, the TTF benchmark price decreased by more than 65% compared with the previous year, due to the easing of the supply risks that emerged in 2022, the year in which gas flows ceased from Russia, the main supplier to the European market.
However, the gas market remained highly volatile and very sensitive to the upward shocks recorded during the year, reflecting the fragility of the balance between supply and demand, although prices never touched the levels reached in 2022. Price volatility was moderated by the achievement of a high percentage of filled storage (above 90%) before the start of the winter season, which combined with mild temperatures in November and December led to a sharp reduction in gas prices in Europe in the final months of 2023, falling below €35/MWh.

The developments in gas prices, together with high levels of storage, in turn drove a decrease in coal prices, which in 2023 averaged $129/ton (-55.5% on the previous year). The dynamics of the gas market have also made coal-fired generation less attractive, discouraging its consumption and encouraging accumulation of the commodity.

In the first half of 2023, oil prices declined in response to the normalization of supply and expectations of a weak recovery in demand. During the second half, however, prices jumped considerably, reaching a peak in September, reflecting the impact of additional cuts in supply combined with growing demand. In the last quarter of 2023 the price trend reversed again, with Brent prices falling below $75 a barrel. In 2023, the European benchmark price averaged $82 a barrel, 17% lower than the previous year.

		2023	2022	Change
Brent	$/barrel	82	99	-17.2%
API2	$/ton	129	290	-55.5%
TTF	€/MWh	41	120	-65.8%
CO_2	€/ton	84	81	3.7%
Copper	$/ton	8,495	8,831	-3.8%
Aluminum	$/ton	2,256	2,706	-16.6%
Lithium carbonate	$/ton	36,762	71,640	-48.7%
Polysilicon	$/ton	16,441	35,589	-53.8%

In contrast to developments in other energy commodities, 2023 saw a slight increase in CO_2 prices in the ETS, which rose by about 4% compared with the previous year. On a monthly basis, prices displayed a downward trend in the second half of the year, mainly due to low demand for allowances from both ordinary market participants and speculative operators.
In the wake of developments in the second half of 2022, weak economic growth and the increasingly tense geopolitical context dominated metals markets in 2023, exacerbated in the final part of the year by the resurgence of conflict in the Middle East.
As often happens in commodity markets, China again had a decisive impact on market balances and price trends. Following the easing of logistical issues in 2022, fears of a slowdown in growth and the crisis in the construction sector dampened demand, and therefore prices, for the Asian giant as well.

As regards base metals such as aluminum and copper, the prices of which are highly correlated with economic and industrial activity, the weakness of economic conditions caused the prices of both to perform less strongly than expected. Copper prices recorded an overall decrease in the first half of 2023 before stabilizing from June onwards, recording an average price of $8,495/ton in the year, down by 3.8% compared with 2022. Aluminum performed even worse, with the price remaining weak throughout the year, closing 2023 with an average of $2,256/ton, down by 16.6% compared with the average for 2022.
A similar pattern was displayed by steel prices, which after an initial rise at the beginning of the year, quickly retreated and closed 2023 at an average price of $580/ton, down by 15% compared with 2022.
As regards the metals most closely involved in renewable energy technologies, such as lithium for batteries or the polysilicon used in the manufacture of photovoltaic panels, 2023 prices showed declines compared with 2022 that were even larger than those registered by base metals. Lithium, which was adversely impacted by lower-than-expected demand for batteries and, above all, by a strong expansion of supply, both internally in China and from Australia and South America, saw 2023 prices fall constantly during the year to close at an average price of about $36,000/ton, down by almost 50% compared with 2022. Similar developments were registered for polysilicon prices, which following sharp declines beginning in December 2022 remained very weak throughout 2023, posting an average of about $16,000/ton, down by about 54% compared with 2022.

Electricity and natural gas markets

Electricity demand

Developments in electricity demand[1]

TWh

	2023	2022	Change
Italy	**306.1**	**315.0**	**-2.8%**
Spain[2]	239.9	250.0	-4.0%
Romania	54.0	57.5	-6.1%
Argentina	145.9	144.0	1.3%
Brazil	653.8	611.0	7.0%
Chile	83.4	83.2	0.2%
Colombia	80.0	76.9	4.0%

(1) Gross of grid losses.
(2) National data.
Source: Enel based on TSO figures. The figures are the best estimate available at the publication date and could be revised by TSOs in the coming months.

Electricity consumption in Europe decreased in 2023, mainly reflecting high temperatures and a slowdown in economic activity.
Italian electricity demand closed 2023 with a contraction of 2.8% compared with 2022. Monthly electricity consumption in the first nine months of 2023 was consistently lower than the previous year, with a slight recovery in the last quarter that was not sufficient to offset the losses accumulated in the previous months, again reflecting mild temperatures and weak industrial activity. The decrease recorded in Spain was larger at 4.0%, reflecting the slowdown in the industrial and service sectors, combined with the effect of milder temperatures. Demand in Romania also fell sharply, recording a decrease of 6.1% compared with the previous year.

Latin American countries bucked the trend, with electricity demand increasing compared with 2022, mainly sustained by continuing favorable economic growth developments. Particularly large rises were posted in Brazil (+7.0%) and Colombia (+4.0%), while more modest increases were registered in Chile (+0.2%) and Argentina (+1.3%).

Electricity prices

Electricity prices

	Average baseload price 2023 (€/MWh)	Change in average baseload price 2023-2022	Average peakload price 2023 (€/MWh)	Change in average peakload price 2023-2022
Italy	**127.4**	**(175.7)**	**137.4**	**(200.3)**
Spain	87.4	(80.3)	82.7	(86.3)

Electricity prices in Italy and Spain fell sharply in 2023 compared with 2022, reflecting the decrease in prices on energy commodity markets during the year. More specifically, a sharp decrease in the price of gas, together with an increase in renewable generation, caused electricity prices in Italy to decrease by 58% compared with the previous year. Less marked but still substantial was the decrease registered in Spain (-48%), where prices in 2022 had risen less than in other European countries, thanks to the strong presence of renewable generation and, above all, to regulatory measures introduced to limit the impact of the increase in gas prices. Consumer prices per kWh also fell significantly compared with 2022, with the exception of residential prices in Italy, which rose in the first half of the year.
The table below summarizes final market prices for the main consumption segments.

Price developments in the main markets

Eurocents/kWh

	2023	2022	Change
Final market (residential)(1)			
Italy	0.3230	0.2932	10.2%
Spain	0.1534	0.2773	-44.7%
Final market (industrial)(2)			
Italy	0.2031	0.2870	-29.2%
Spain	0.1085	0.1917	-43.4%

(1) Annual price net of taxes - annual consumption of between 2,500 kWh and 5,000 kWh.
(2) Annual price net of taxes - annual consumption of between 70,000 MWh and 150,000 MWh.
Source: Eurostat.

Natural gas markets

Natural gas demand

Billions of m³

	2023	2022	Change	
Italy	**60.7**	**67.5**	**(6.8)**	**-10.1%**
Spain	28.5	31.3	(2.8)	-8.9%

The underlying factor in the decline in gas prices was a decrease in gas consumption. In 2023, demand contracted sharply compared with the previous year. In Italy and Spain, gas demand decreased by 10.1% and 8.9% respectively, reflecting the mild temperatures recorded during the year, an increase in electricity generation from renewable sources and the continued weakness of industrial production, which is still below pre-crisis levels.

Italy

Natural gas demand in Italy

Billions of m^3

	2023	2022	Change	
Distribution grids	26.7	28.8	(2.1)	-7.3%
Industry	11.5	11.9	(0.4)	-3.4%
Thermal generation	21.2	25.1	(3.9)	-15.5%
Other[1]	1.3	1.7	(0.4)	-23.5%
Total	**60.7**	**67.5**	**(6.8)**	**-10.1%**

(1) Includes other consumption and losses.
Source: Enel based on data from the Ministry for Economic Development and Snam Rete Gas.

In Italy, demand decreased by 10.1% compared with 2022. Analyzing consumption by sector, thermal generation registered a particularly large decline (-15.5%), mainly due to the replacement of gas generation with renewable generation. This is followed by distribution grids (-7.3%), where the decrease reflected mild temperatures in the first and fourth quarters. Less marked but still significant was the decrease recorded in industry (-3.4%).

Competitive and transition environment

Assessing the evolution of the energy transition process is a fundamental input in the definition of Enel's strategy. This assessment is particularly critical in the current environment, characterized, as discussed in earlier sections, by growing geopolitical tensions, high interest and inflation rates and supply chain difficulties. At the same time, the objectives of the Paris Agreement require an acceleration of the energy transition, in order to limit the increase in average global warming to 1.5 °C compared with pre-industrial levels. The recent COP 28 on climate change held in Dubai established the objective of gradually transitioning away from fossil fuels by 2050 and tripling renewables capacity by 2030 (11 TW vs 3.6 TW in 2022), in line with the International Energy Agency (IEA) Net Zero[12] and the International Renewable Energy Agency (IRENA) 1.5[13] scenarios.

The transition is shifting gears at the global level, as demonstrated in particular by the increase in renewables capacity, which saw over 500 GW of capacity installed in 2023 alone.[14] According to the IEA, the decline in all fossil fuels will begin within this decade under current policy scenarios.[15] Nonetheless, a broad gap persists between today's ambitions and holding the temperature increase to below 1.5 °C, as well as local differences in the pace of progress towards the goals that each country has set itself. This gap is largely connected with the need to introduce measures to implement the long-term objectives, with a view to increasing both the development of renewables and the rate of electrification of consumption in the short term. More specifically, in the IEA's announced pledges scenario (APS), capacity reaches a total of almost 10 TW, and is therefore still not consistent with the latest agreements.

Furthermore, while on the one hand we are witnessing a convergence of calls for energy security, accessibility and sustainability, which is guiding everyone – political decision-makers, citizens and companies – towards an acceleration of the clean electrification process, in reality the energy transition is proceeding along a path of disorderly policies ("disorderly transition"[16]) compared with expectations. In some geographical areas, the speed of the transition is not as rapid as expected, as measured by sales of electric cars and heat pumps – the main drivers of the increase in electricity demand. Although they are expanding steadily, they do not yet have a significant impact on global energy consumption.

In a year characterized by high interest rates, inflation and supply chain difficulties, the utilities sector, and integrated utilities in particular, has demonstrated resilience to external developments, thanks in part to the normalization of commodity prices, as well as the balance achieved between industry, with investments to expand renewable generation capacity and strengthen grid infrastructure, which lower risk. This positioning reaffirms the crucial role of utilities in the context of the transition and manifests the commitment to energy security.

(12) Source: IEA, 2023, World Energy Outlook.
(13) Source: IRENA, 2023, World Energy Transition Outlook.
(14) Source: IEA, 2023, Renewables Report.
(15) Stated Policies Scenario (STEPS). Source: IEA, 2023, World Energy Outlook.
(16) According to the definition of the Network for Greening the Financial System, 2022, "Scenarios for central banks and supervisors".

With the evolution of markets, the electricity generation and sales sector, together with related services and products, is experiencing an increase in competition, often a reflection of the strategic repositioning of companies in related sectors. Although this is producing a potentially more challenging competitive environment due to the presence of multiple operators, it also opens the way to new business opportunities, the identification of new areas of value, the creation of synergies and the development of potential partnerships.

Climate change and long-term scenarios

Enel promotes transparency in its climate-change impact disclosures and works to demonstrate to its stakeholders that it is tackling climate change with diligence and determination, consistent with the guidelines and requirements set out in the most recent disclosure standards. The Group was one of the first utilities to take on board the "Guidelines on reporting climate-related information" published by the European Commission in June 2019, which, together with sustainability reporting standards such as the GRI Standards, represent a benchmark for the Group's reporting on climate change issues.

Scenario analysis and planning

The Group develops short-, medium- and long-term scenarios for macroeconomic, financial, energy and climate developments in order to support planning, capital allocation, strategic positioning and the assessment of the risks and resilience of the strategy. Scenario-based planning involves defining alternative scenarios developed on the basis of a number of key uncertainty variables, such as achieving the goals of the Paris Agreement. The development of scenarios allows companies to explore and model plausible alternative futures, designing various paths forward with different timing and options, and ultimately to support strategic decision-making with a view to maximizing opportunities and mitigating risks.
To support analysis of scenarios and the evolution of the external context, the Group identifies and analyzes short-, medium- and long-term trends to develop an overview of how the structural forces and macro-trends are influencing the speed of the transition and of the expected impacts in the energy sector, especially in the businesses in which Enel operates. This mapping of trends provides a reference foundation for developing actions to orient the positioning of the business, seizing the opportunities offered by the context.

Scenario benchmarking

Benchmarking of external energy scenarios is a key starting point in order to build robust internal scenarios. There are many global, regional and national energy transition scenarios published by various providers and designed for a wide range of purposes, from government planning and policy-making to the support of enterprise decision-making processes. Benchmarking entails analyzing external transition scenarios in order to compare results in terms of the energy mixes, trends in emissions, and technology decisions and to identify the main drivers of the energy transition for each.

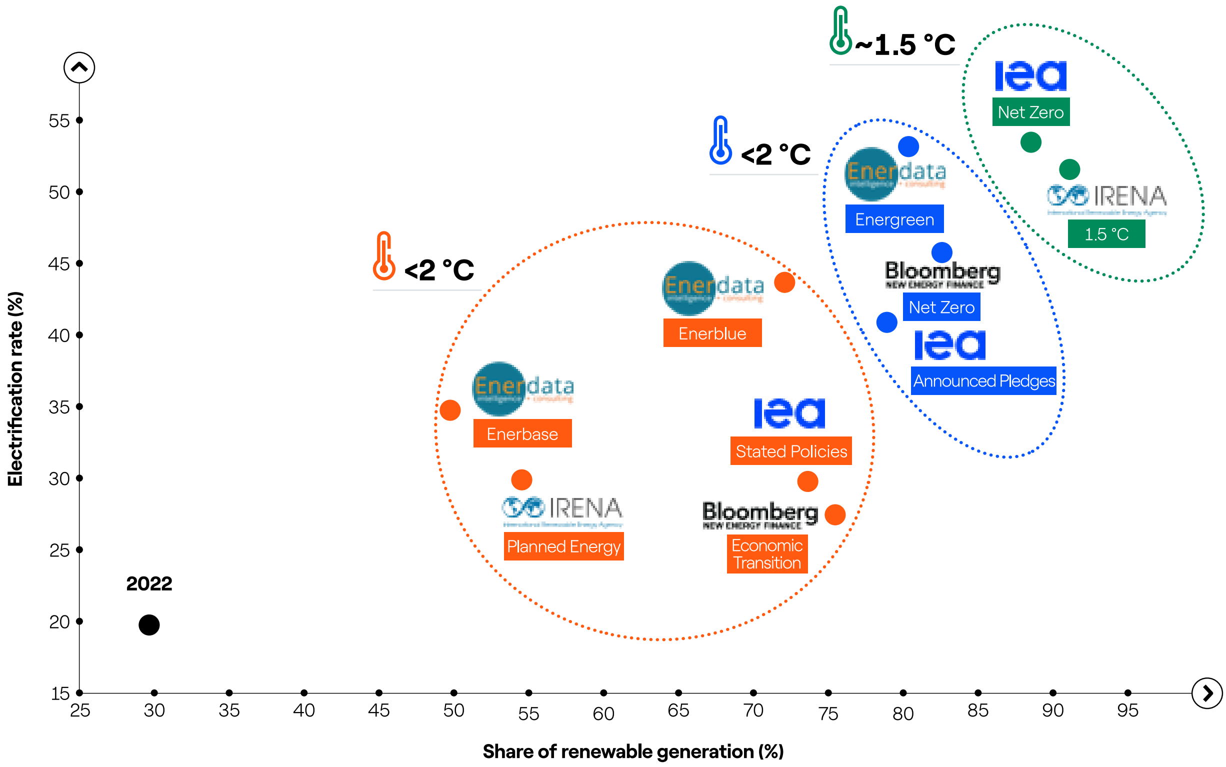
Enel's benchmarking of external energy transition scenarios comprises the following steps.

1. **Analysis of the context of global and national scenarios for the countries in which we operate.** The analysis of scenarios, as well as the study of reports and datasets, is supported by constant dialogue with the analysts of the main scenario providers. Global energy scenarios are typically grouped by family based on the degree of climate ambition, as follows:
   - Stated-policies scenarios : based on current policies, or Business-as-usual ;
   - Paris-Aligned scenarios : these are aligned with the Paris Agreement, i.e. are compatible with the goal of limiting the increase in average global temperatures to "well below 2 °C" above pre-industrial levels;
   - Paris-Ambitious/Net Zero scenarios : global energy scenarios that take a path towards net-zero emissions by 2050, in line with the most ambitious goal of the Paris Agreement, i.e. to keep the average increase in global temperatures to 1.5 °C, albeit with various probability intervals.
2. **Data collection, data analysis and identification of scenario and energy transition drivers.** The data regards all the main metrics of the energy system, including, for example: primary energy, total and sectoral final energy, electrical capacity by technology, electricity generation by technology, hydrogen production, electric vehicle fleet, etc. The data analysis gives each provider an understanding of the key elements of the Business-as-usual/ Stated-policies scenarios and leads to the identification of the drivers for accelerating the energy transition in the Paris-Aligned and Paris-Ambitious scenarios.
3. **Preparation of a summary of the data analysis and digital representation of the main metrics of external scenarios**, to provide support for management in the decision-making process for the Group's scenario framework. This activity is an integral part of internal planning processes.

The main transition drivers: electrification and renewables

Analyzing the various external scenarios, the consensus among energy analysts is clearly that the main drivers for achieving climate objectives are electrifying final uses and increasing renewable generation in both the medium and long term. In particular, in the scenarios that envisage containing the increase in the global average temperature to 1.5 °C, the rate of electrification of consumption rises to over 50% by 2050, compared with 20% in 2022,[17] while the share of renewable generation will reach around 90% of the global electricity mix, compared with 30% in 2022.[18]

RENEWABLE GENERATION AND ELECTRIFICATION IN GLOBAL TRANSITION SCENARIOS AT 2050



Source: based on data from IEA World Energy Outlook 2023, BNEF New Energy Outlook 2022, IRENA World Energy Transition Outlook 2023 and Enerdata Enerfuture 2023.

(17) IEA, 2023, World Energy Outlook: 53%; IRENA, 2023, World Energy Transition Outlook: 51%.
(18) IEA, 2023, World Energy Outlook: 89%; IRENA, 2023, World Energy Transition Outlook: 91%.

Enel's energy transition and climate change scenarios

Enel develops scenarios within an overall framework that ensures consistency between the energy transition scenario and the climate physical scenario:

- the "energy transition scenario" describes how energy production and generation evolve in the various sectors in a specific economic, social, policy and regulatory context;
- the issues connected with future trends in climate variables (in terms of acute and chronic manifestations) define the "physical scenario".

	GRANULARITY & EXTENDED GEOGRAPHICAL COVERAGE	FORWARD-LOOKING METRICS & KPIs	AUTOMATION AND ADVANCED ANALYTICAL TECHNIQUES	INTEGRATION OF INTERDEPENDENCIES	OPEN DATABASES AVAILABLE TO STAKEHOLDERS
MACROECONOMICS AND FINANCE	**More than 150 countries monitored** for analysis of country risk and macroeconomic-financial scenarios	Monitoring of market expectations and **sensitivity analysis** of new social and technology paradigms	**General equilibrium models** and **machine-learning** techniques to manage **big data**	Incorporation of **social-environmental effects** in analyses to quantify effects of actions taken (e.g., TSI)	Periodic updating on **interactive platforms** with optimization for **graphical analysis**
ENERGY	**Broad coverage** of market and geographical indicators and **starting-point focus areas**	Monitoring of trends in electricity demand and price volatility. With analysis of **regulatory and transition impacts**	Econometric models and **neural networks** to produce forecasts	Impact analysis with **exogenous variables** (macroeconomic and climate)	Development of **integrated database** updated automatically
CLIMATE	Climate scenario data available with **worldwide high-resolution coverage**	**Standard and/ or** ad hoc **metrics** to assess **developments** in **future scenarios**	**Analytics** and **machine learning** to manage **georeferenced big data** in **downloadable cloud environments**	Integration of **exposure** data (e.g., demographic density, asset location/value)	**Platforms for sharing, visualizing and downloading** results
INTEGRATED SYSTEM MODELS	Main countries of interest for Enel. Developed to manage **integrated business models**	Development of scenarios by economic sector to identify trends in **electrification and efficiency**	Use of system models to optimize the use of technologies to **minimize emissions and costs**	Integrated management of both **energy supply** and **demand**	**Technology database** for each service: types of electric vehicles, heat pumps, etc.

The acquisition and processing of the large volume of data and information needed to define the scenarios, and the identification of the methodologies and metrics necessary to interpret phenomena that are complex and – in the case of climate scenarios – at very high resolution, require a continuous dialogue with both external and Enel internal sources. In order to evaluate the effects of physical and transition phenomena on the energy system, the Group makes use of models that, for the main Group countries involved in the analysis, describe the energy system in terms of specific technological, socio-economic, policy and regulatory aspects.

The adoption of energy and physical scenarios and their integration into corporate processes take account of the most recent climate-change reporting standards and enable the assessment of the risks and opportunities connected with climate change. The process that translates scenario phenomena into useful information for industrial and strategic decisions can be summarized in five steps.

1. **Identification of trends and factors** relevant to the business (e.g., electrification of consumption, heat waves, etc.)

2. Development of **link** functions connecting climate/transition scenarios and operating variables

3. Identification of **risks** and **opportunities**

4. **Calculation of impacts** on business (e.g., change in performance, losses, Capex)

5. **Strategic actions**: definition and implementation (e.g., capital allocation, resilience plans)

Enel's energy transition scenarios

An energy transition scenario describes how energy production and consumption can evolve in a specific geopolitical, macroeconomic and regulatory and competitive context consistent with the available technological options. This corresponds to a certain trend in greenhouse gas (GHG) emissions and a climate scenario and, therefore, a certain increase in temperature by the end of the century compared with pre-industrial levels. It should be noted that the resulting climate scenario is not deterministic with respect to carbon dioxide emissions. For each climate scenario, the IPCC also always provides both the median value for global warming in 2100 and the very likely range (i.e. the interval between the 5th and 95th percentiles).

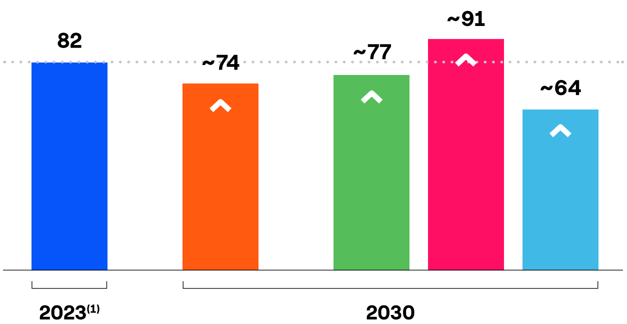
The main assumptions considered in developing the Enel energy transition scenarios concern the macroeconomic and energy context, local policies and regulatory measures, the evolution, costs and adoption of energy production, conversion and consumption technologies.

The Reference scenario for planning is a Paris-Aligned scenario, calling for achievement of the objectives of the Paris Agreement, i.e. keeping the increase in the global average temperature below 2 °C compared with pre-industrial levels, with a level of climate ambition that is higher than Business-as-usual, but without necessarily assuming the global achievement of the Net Zero 2050 target, given the current global level of cumulative ambition and the deceleration of the energy transition caused by the impact on certain transition variables of current macroeconomic and energy conditions at the local level.

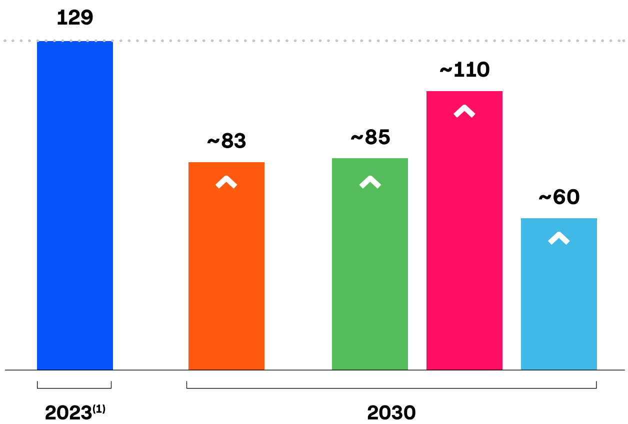
In order to assess the risks and opportunities inherent in the energy transition, alternative scenarios to the reference framework have been defined on the basis of the degree of climate ambition assumed at the global and local level. These comprise: a Slower Transition scenario, characterized by an energy transition in which the near-term slowdown in the transition in certain areas has a greater overall impact in the medium term, and an Accelerated Transition scenario, with greater ambition compared with the Reference scenario, in particular as regards certain variables.

The assumptions for trends in commodities prices underlying the Reference scenario are consistent with the external scenarios that achieve the objectives of the Paris Agreement. More specifically, we assume sustained growth in the price of CO_2 through 2030, caused by a gradual reduction in the supply of allowances as demand increases, as well as a significant decrease in the price of coal due to declining demand. As for gas, we expect pricing pressures to lessen in the coming years as we see a realignment between global supply and demand. Finally, we are forecasting a gradual stabilization in oil prices, with demand expected to peak by around 2030.

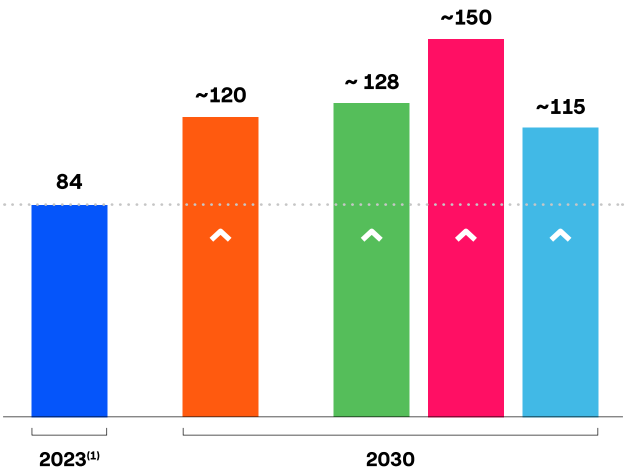
BRENT ($/barrel)



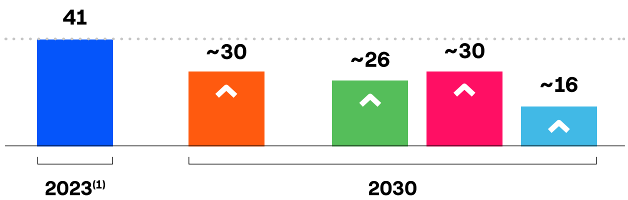
API2 ($/ton)



CO_2 EU - ETS (€/ton)



TTF (€/MWh)



Enel scenario | Average benchmark[2] | Max benchmark | Min benchmark

(1) Actual.
(2) Sources: IEA - Sustainable Development Scenario and Net Zero Scenario; BNEF, IHS green case scenario; Enerdata green scenario. N.B. The scenarios used as benchmarks have been published at various points throughout the year and may not be up to date with the latest market trends.

The alternative scenarios envisage both an acceleration in decarbonization, driven by regulation, and at the same time a more rapid decline in demand for fossil fuels, which inevitably translates into lower prices for these commodities by 2030. In the case of a slower transition, fuel demand will reach its peak more gradually, and this will support energy commodity prices.

With regard to full achievement of the Paris Agreement objectives, i.e. to stabilize global average temperatures to within +1.5 °C, there remain uncertainties that a number of countries could remain on business-as-usual trajectories and not adopt effective measures to reduce their emissions in a timely manner, thereby slowing the decarbonization process towards net-zero emissions by 2050.

Nevertheless, the Enel Group operates a business model and has defined strategic guidelines that are in line with the maximum ambition of the Paris Agreement objectives, i.e. they are consistent with an increase of 1.5 °C in the average global temperature by 2100, as certified by the Science Based Targets initiative (SBTi). Enel has set a goal for 2040 to achieve zero direct emissions (Scope 1), with totally renewable electricity generation and zero emissions connected with retail energy sales (Scope 3).

Local transition scenarios

The scenarios have been defined at the local level using two complementary approaches:

- in the main countries in which we operate, the Group has developed dedicated models for the simulation of the long-term equilibrium of the entire energy system. The values of the scenario variables of relevance to the activities of the Group were then calculated using those models with a view to minimizing costs for the system, imposing a constraint on long-term CO_2 emissions consistent with the achievement of the Paris Agreement objectives and interim constraints dictated by policies in existence or being adopted in each country, taking due account of short-term market dynamics and the diffusion of technologies particular to each of those countries;
- for the rest of the countries involved, the main scenario variables were determined by applying statistical analysis to internal and consensus data in relation to external scenarios aligned with the objectives of the Paris Agreement as provided by national and international accredited bodies.

The definition of internal transition scenarios was prompted by the need for greater modeling flexibility and greater geographical and operational granularity for the main variables that impact Enel's different businesses compared with the scenarios that the main external providers can provide. The latter are typically produced and published at a global or regional level, with some exceptions for particularly large countries, which only rarely correspond to the countries in which the Group is present or has an interest.

Italy

For Italy, the Reference scenario takes account of the recent developments in European climate and energy legislation. The results at 2030 are therefore comparable with those contained in the draft National Integrated Energy and Climate Plan (NIECP), published in June 2023, with certain elements added to ensure greater fit with current market dynamics. The Slower Transition scenario has been constructed assuming a slower energy transition, with less rapid development of renewables capacity, electric mobility and green hydrogen production. The Accelerated Transition scenario assumes a quicker reform of authorization processes and support mechanisms for renewable energy plants, which accelerates installation, and lower costs for green hydrogen production technologies.

Spain

For Spain, the Reference scenario also envisages a level of climate ambition and objectives for renewables and energy efficiency that take account of recent developments in European climate and energy legislation and is therefore comparable with the draft NIECP published in June 2023. The scenario envisages rapid growth in renewables, particularly solar, in the next few years. It differs from the NIECP draft at 2030 in its assumption of slower development of green hydrogen.
The alternative Slower Transition scenario assumes a lag in the penetration of renewables, green hydrogen and electric technologies, in particular with regard to private automobiles and the electrification of domestic consumption. The Accelerated Transition scenario envisages a more rapid implementation of authorization procedures for renewables, increasing annual installation levels, and a development of green hydrogen consistent with the draft NIECP, as well as a further effort to achieve energy savings in buildings.

Brazil

For Brazil, the Reference scenario envisages an increase in electrification at 2030, with a growing level of renewables generation, in particular solar and wind, and the start of green hydrogen production after 2027, with a more ambitious view compared with the most recent energy plan.[19]
In the transport sector, it takes account of biofuel incentive policies and assumes an increase in electrification. The Slower Transition scenario is constructed on the assumption of a less optimistic macroeconomic environment than the Reference scenario, especially in the years up to 2030, with slower expansion of renewables capacity and a consequent slower trend line in emissions reduction. The Accelerated Transition scenario goes beyond the ambition of the Reference scenario regarding the speed of decarbonization, mainly after 2030, assuming an acceleration in the penetration of renewables, green hydrogen and storage.

(19) Brazil's most recent energy plan is from 2022 (Plano Decenal de Energia 2031); an update is expected in 2024.

Chile

As far as Chile is concerned, the **Reference** scenario is consistent with the Net Zero scenario defined in the government's PELP document (*Planificación Energética* **a Largo Plazo 2023-2027**), published in 2021, in terms of emissions reductions, and includes ambitious targets for the production and export of green hydrogen. The **Slower Transition** scenario takes a more measured approach, using more conservative macroeconomic growth assumptions with no additional energy or climate policies beyond those already in place. The **Accelerated Transition** scenario achieves net-zero emissions by 2050 and, compared with the **Reference** scenario, provides for more ambitious goals for the export of green hydrogen, an acceleration in the electrification of the residential and industrial sectors, and the phase-out of coal by 2030.

Colombia

As for Colombia, the **Reference** scenario envisages reducing emissions by 40% by 2030 compared with 2021, a moderately less ambitious target than the National Determined Contribution (NDC) objective,[20] and close to zero emissions in the electricity sector by 2050. In the **Reference** scenario, renewables capacity increases considerably by 2030, and envisages further growth connected with green hydrogen after 2030, albeit more conservatively compared with the expectations set out in the national strategy.[21] The **Slower Transition** scenario is characterized by emissions trends consistent with the **Actualización** scenario in the government strategy document,[22] which assumes more conservative macroeconomic growth and no additional energy or climate policies beyond those already in place. The **Accelerated Transition** scenario envisages an acceleration of the electrification process in the residential and industrial sectors, together with greater growth expectations for the use of renewable sources.

The physical climate scenario for adaptation actions

Within the framework delineated above, each scenario narrative has been developed so as to ensure consistency between the energy transition scenarios and the climate scenarios.

Under the scenarios, the role of climate change is always the most important and generates effects both in terms of transitioning the economy towards net-zero emissions and in terms of physical impacts, which may be:

- acute phenomena, namely short-lived but intense phenomena, such as flooding, hurricanes etc. with potential impacts on assets (e.g., physical losses and business interruptions);
- chronic phenomena related to structural changes in the climate, such as the rising trend in temperatures, rising sea levels etc., which may cause persistent changes in the output of generation plants and in electricity consumption profiles in the residential and commercial sectors.

The projected future behavior of these phenomena is analyzed by selecting the best data available from the output data of climate models at different resolution levels and historical data.

The Group has selected three of the global climate pathways developed by the IPCC, which are in line with those of the IPCC's sixth Assessment Report (AR6). These scenarios are associated with emission patterns linked to a level of the Representative Concentration Pathway, each of which is connected to one of the five scenarios defined by the scientific community as Shared Socioeconomic Pathways (SSPs). The SSP scenarios include general assumptions concerning population, urbanization, etc. The three physical scenarios analyzed by the Group are as follows:

- SSP1-RCP 2.6: compatible with a range of global warming below 2 °C from pre-industrial levels (1850-1900) by 2100 (the IPCC forecasts an average of about +1.8 °C from 1850-1900). In the analyses that consider both physical and transition variables, the Group associates the SSP1-RCP 2.6 scenario with the **Reference** and **Accelerated Transition** scenarios.
- SSP2-RCP 4.5: compatible with an intermediate scenario that calls for an average temperature increase of about 2.7 °C by 2100 from pre-industrial levels. The RCP 4.5 scenario is the one that is most representative of the world's current climate and political landscape and correlated transition assumptions. This scenario forecasts global warming in line with the estimates of temperature increases that consider current policy around the world.[23] In the analyses that consider both physical and transition variables, the Group associates the SSP2-RCP 4.5 scenario with the **Slower Transition** scenario.
- SSP5-RCP 8.5: compatible with a scenario where no particular measures to combat climate change are im-

(20) NDC presented by Colombia in 2020, which provides for a 49% reduction in emissions by 2030 compared with 2021.
(21) Hoja de Ruta del Hidrógeno Colombia, 2021.
(22) Hoja de Ruta de la Transición Energética Justa, 2023.
(23) Climate Action Tracker Thermometer, estimates of global heating at 2100 considering existing policies and actions, and 2030 targets only (December 2023 update).

plemented. This scenario forecasts an increase in global temperatures of about 4.4 °C from pre-industrial levels by 2100.

The Group considers RCP 8.5 to be a worst-case climate scenario used to assess the effects of physical phenomena in a context of particularly significant climate change, but it is currently deemed not very likely. This RCP 2.6 scenario is used both to assess physical phenomena and perform analyses that consider an energy transition consistent with most ambitious mitigation objectives.

The analyses carried out for the physical scenarios considered both chronic and acute phenomena. For the description of specific, complex events, the Group considers data and analyses of public bodies, universities, and private-sector entities.

The climate scenarios are global and must be analyzed at the local level in order to determine their impact in the areas of relevance to the Group. Among active partnerships, collaboration is under way with the Earth Sciences Department of the International Centre for Theoretical Physics (ICTP) in Trieste. As part of this collaboration, the ICTP provides projections for the major climate variables with a grid resolution of varying from about 12 km to 100 km and a forecast horizon running from 2020 to 2050.(24) The main variables are temperature, rain and snowfall, and solar radiation. Compared with past analyses, current studies are based on the use of multiple regional climate models: the one of the ICTP along with other simulations, which have been selected as being representative of the set of climate models currently available in the literature.(25) The output of this set is representative of the average of the various climate models. This technique is usually used in the scientific community to obtain a more robust and bias-free analysis, mediating the different assumptions that could characterize the individual model.
For certain specific climatic variables, such as wind gusts, the Group also uses other providers specialized in that particular phenomenon.

In this phase of the study, future projections have been analyzed for Italy, Spain and all countries of interest to the Group in South America, Central America, North America and Africa, obtaining – thanks to the use of the set of models – a more highly defined representation of the physical scenario. Similarly, the Group is also analyzing data related to climate projections for Africa, Southern Asia and Southeast Asia, thereby covering all of the main geographical areas in which the Group is present at the global level.
The ICTP is also providing science support to interpret all other climate data we gather. We are using climate scenarios for the countries of interest to the Group to allow for a uniform assessment of climate risk.

Some of these phenomena entail high levels of complexity, as they depend not only on climate trends but also on the specific characteristics of the territory and require further modeling to obtain a high-resolution representation. For this reason, in addition to the climate scenarios provided by ICTP, the Group also uses natural hazard maps. This tool makes it possible to obtain, with a high spatial resolution, recurrence intervals for a series of events, such as storms, hurricanes and floods. As described in the section "Risks and strategic opportunities associated with climate change", these maps are widely used within the Group, which already uses historical data to optimize insurance strategies. In addition, work is under way to be able to take advantage of this information developed in accordance with climate scenario projections.
Finally, the Group has acquired the tools and capabilities needed to autonomously gather and analyze the raw output published by the scientific community, so as to have a global, high-level view of the long-term trends in the climate variables of interest to us. These sources include the output from the climate and regional models CMIP6(26) and CORDEX.(27) CMIP6 is the sixth assessment of the Coupled Model Intercomparison Project (CMIP), which is a project of the World Climate Research Programme (WCRP) and of the Working Group of Coupled Modelling (WGCM), which provides raw climate data from global climate models. These are used to assess standard global measurements at a resolution of about 100x100 km. The Coordinated Regional Climate Downscaling Experiment (CORDEX) also falls within the scope of the WCRP and generates regional climate forecasts at a higher resolution.

(24) The climate forecasts mainly cover the RCP 2.6 and RCP 8.5 scenarios. Where available, the RCP 4.5 scenario is also provided. Otherwise, it is derived from the other scenarios using a pattern-scaling approach.
(25) The number of models used varies depending on the RCP scenario.
(26) https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6.
(27) https://cordex.org/.

Physical scenario analysis – Integration of climate scenarios within the Open Country Risk model

In addition to using high-resolution data to analyze the impact of physical phenomena, the Group has also designed a higher-level analysis framework that enables us to obtain a country-level assessment of trends in certain global climate hazards in a manner that is consistent across all regions. More specifically, we have adopted a modular approach that will enable us to progressively upgrade our analyses by including new physical phenomena and refining both the data and our methodologies. At present, four climate phenomena are included: two related to extreme temperatures; one related to intense rainfall; and one related to drought. The possibility of introducing other phenomena such as extreme wind and sea level rise is also being evaluated. The phenomena are assigned a numerical index based on the global distribution to a resolution of about 100x100 km and are summarized in a composite index. This has enabled us to include a dimension related to climate change in the Open Country Risk model. This enables the tool to include both the aspects considered by the Open Country Risk models and those aspects related to the physical risks considered in the model as a cause of environmental and economic stress in a given country. The Open Country Risk model is described in greater detail in the section "Macroeconomic and geopolitical trends".

Physical scenario analyses

Acute phenomena

Heat waves

Extreme temperatures can be studied using the standard indicator "Warm Spell Duration Index" (WSDI). This metric considers heat waves characterized by at least six consecutive days with a maximum daily temperature above the 90th percentile of the historical distribution.[28]

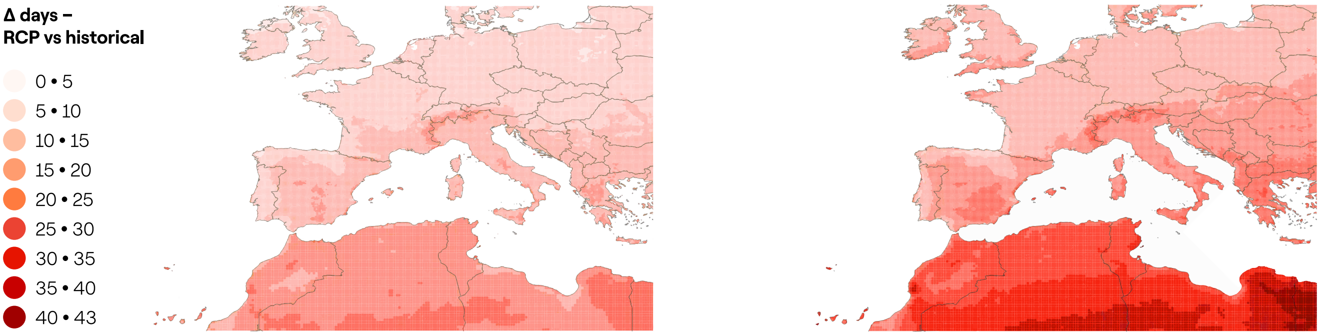
In general, as can be seen in the following figure, in central and southern Europe the number of days of acute heat defined in accordance with the WSDI will increase in all future scenarios in the 2030-2050 period compared with the historical benchmark (1990-2020). In the RCP 2.6 scenario, most of the Italian peninsula will see an increase in the average number of days per year with heat waves (from +10 to +15 days) compared with a historical annual average of around 20-25 days. This increase will be larger in the Alpine areas bordering France and Switzerland and in some areas in southern Italy, with a change of +15 to +20 days. The situation in Italy is also worsening in the RCP 8.5 scenario, where the expected increases are up to +30 days compared with the 1990-2020 period. Spain will see similar changes, with heat waves also becoming more widespread geographically and more frequent in the 2030-2050 period. Compared with past years characterized by around 20 warm-spell days, in the RCP 2.6 scenario this phenomenon will increase by between +10 to +15 days in almost all of Spain.

In the RCP 8.5 scenario, the duration of heat waves will be even longer, especially in the southern part of the country (mainly from +20 to +25 days, with peaks of up to +37 days in certain coastal locations on the Mediterranean).

(28) The scientific literature offers various indicators for measuring the same physical phenomenon. Where necessary, Enel also calculates specific ad hoc metrics to analyze acute events relevant to the various global business lines.

RCP 2.6

RCP 8.5

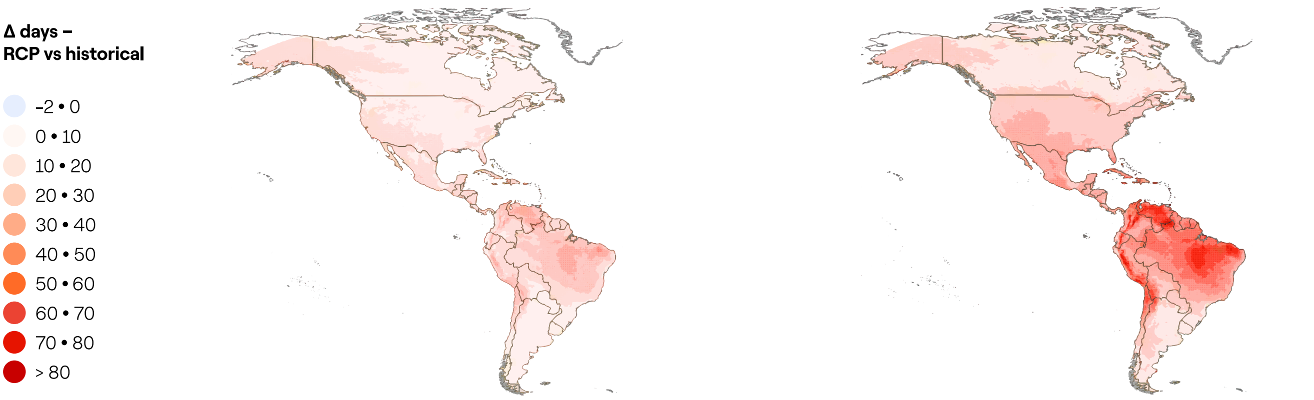


Average change in number of days per year experiencing a heat wave (in accordance with WSDI definition) in the RCP 2.6 and RCP 8.5 (2030-2050) scenarios compared with the historical benchmark (1990-2020) in central and southern Europe.

The number of days characterized by heat waves calculated according to the WSDI is also expected to increase in the Americas in all future scenarios (see the following figure).
Comparing the 2030-2050 period with the 1990-2020 period, South America should already experience a significant increase in days of heat waves in the RCP 2.6 scenario, especially in certain areas of Brazil, Colombia and northern Chile. Central America, the western coast of North America and the southern part of the United States are also forecast to see a significant increase in days characterized by heat waves in the RCP 2.6 scenario in the 2030-2050 period compared with the benchmark.
In general, the increase in the number of days with heat waves will be even more pronounced in the RCP 8.5 scenario across the continent.

RCP 2.6

RCP 8.5



Average change in number of days per year experiencing a heat wave (in accordance with WSDI definition) in the RCP 2.6 and RCP 8.5 (2030-2050) scenarios compared with the historical benchmark (1990-2020) in the Americas.

Extreme precipitation
Intense rainfall can be analyzed by estimating the change in daily rainfall above the 95th percentile, calculated in terms of average annual millimeters in the reference periods.
In central and southern Europe, the expected change in acute precipitation in the 2030-2050 period compared with 1990-2020 varies from area to area and depending on the scenario considered.
Specifically, under the RCP 2.6 scenario, Italy is expected to experience a more significant increase in extreme rainfall in the north-east and along the Tyrrhenian coast, while the phenomenon is expected to decrease along the Adriatic coast, in the south and the islands. Under the RCP 8.5 scenario, extreme precipitation is expected to increase in most of Italy, except in the islands and some areas of the center and south-west, where the data point to a slight increase. In Spain, changes are expected in extreme precipitation in most of the territory already in the RCP 2.6 scenario. In particular, intense precipitation will increase slightly in some areas of the north, but will decrease in the south-east. In the RCP 8.5 scenario, heavy rainfall will decrease across the south of the country and the north-west.

Future changes in intense rainfall will differ considerably in the Americas as well. In some areas of South America, such as north and east Brazil, northern Argentina and central-southern Chile, reductions from the historical trends are projected to occur under the RCP 2.6 scenario. In other areas, however, such as in most of Colombia and other areas of Brazil, intense rainfall is forecast to increase. In almost all of North America, acute precipitation is expected to increase in the RCP 2.6 scenario compared with the historical average (although the magnitude of these increases varies from area to area). In Mexico, however, the future change varies depending on the area. Finally, under the RCP 2.6 scenario, intense rainfall will decrease in the central and southern areas of Central America. In other areas, rainfall levels will remain unchanged or increase slightly.

Fire risk

Fire risk can be studied using the Fire Weather Index (FWI), an indicator widely used internationally that takes account of temperature, humidity, rainfall, and wind in order to calculate an estimate of fire risk. Figures provided by the ICTP may be used to describe the trend in fire risk in order to support the business in properly managing this risk. To give a more complete representation of fire risk, we can supplement analysis on this acute phenomenon with a study of vegetation indices, since vegetation can serve as fuel and increase the probability of a fire spreading.[29]

In central and southern Europe, the number of days per year experiencing extreme fire risk (i.e. those with a FWI value > 45) will tend to increase almost everywhere in the 2030-2050 period compared with the 1990-2020 benchmark. The studies conducted for Italy show that the number of days at high risk increase in all scenarios, especially in the summer. This change will be even more accentuated under the RCP 8.5 scenario and mainly affect the islands and southern regions of the country. In general, in these areas the increase in the number of days at extreme risk ranges from approximately +6 to +11 days compared with the historical average. The area of Spain that will see the greatest increase in fire risk is the central south in all future scenarios. This increase is larger in the RCP 8.5 scenario than in the RCP 2.6 scenario.

In the Americas, the expected evolution of extreme fire risk varies from area to area. In South America, in the RCP 2.6 scenario the number of days at high first risk increases in most of Brazil and Chile and in the north-west and south of Argentina. In the remaining areas of the macroregion it remains unchanged or decreases slightly. In North and Central America, high fire risk remains essentially unchanged in most of the macroregion in the RCP 2.6 scenario. Only in the western areas of the United States and Mexico are increases in the number of days at high risk expected, with the increase rising as the scenario become more severe.

Cold snaps

A number of indicators can be used to measure extreme cold-related events.[30] One of these is the frost days index, i.e. the average number of frost days per year.[31]

Comparing the RCP 2.6 scenario (2030-2050) with the historical benchmark (1990-2020), in central and southern Europe the number of frost days will remain unchanged or decrease slightly in all countries. Only in some areas, such as the Alps in Italy and the Pyrenees in Spain, will the number of days of intense cold decrease (from -5 to -10 days compared with the historical benchmark). Under the RCP 8.5 scenario, the decrease in frost days is expected to be more geographically extensive. In northern Italy and in some Apennine areas of the peninsula and in part of northern and central Spain, the forecast is for a reduction of up to 15 days of frost per year, again compared with the benchmark period.

In most of the Americas, the number of frost days will remain unchanged under both RCP scenarios; only in some areas are decreases expected. Latin America will experience a decline in frost days in some central-western and southern areas, and the decrease will be larger under the RCP 8.5 scenario compared with the RCP 2.6. Frost days will decrease in North America and Central America, especially in the western part of the macroregion, with larger and more extensive declines under the RCP 8.5 scenario.

Note that a decrease in frequency does not exclude an increase in the intensity of these acute events, an issue that the Group is currently investigating.

(29) One of the metrics used is obtained using NASA data for the Normalized Difference Vegetation Index (NDVI). NDVI quantifies vegetation by measuring the difference between near-infrared light (which vegetation reflects strongly) and red light (which vegetation absorbs). This is a good indicator of vegetation growth and density. The higher the NDVI, the more abundant and healthier the vegetation.

(30) In addition to the standard indices reported in the scientific literature, **ad hoc** metrics have also been developed to better study the phenomenon at the technology level.

(31) Frost days are days in which the minimum temperature (T_{min}) is less than 0 °C.

Europe: heat waves and climate change

In the summer of 2023, Europe was overwhelmed by heat waves, with exceptionally high temperatures combining with drought and wind to drive the spread of fires. These events fall within a pattern of a significant increase in extreme physical phenomena in recent decades. However, it is important to understand how and to what extent these events are connected to climate change driven by human activities. This is not an easy task, but studies of individual events can help. "Event attribution" science seeks to do just this, providing explanations based on science and thus avoiding the dissemination of misleading or false information. By studying surface pressure, temperature variables and past events, it is possible to establish that phenomena such as the long and intense heat wave of July 2023 (Cerberus) are above all attributable to natural climate variability. By contrast, the anomalous heat wave of August 21-23 that hit central and western Europe was a unique event that can largely be attributed to anthropogenic climate change.[32]

In general, event attribution studies indicate that, on average, in Europe:

- a heat wave that in the pre-industrial climate would have occurred 1 time every 10 years is now expected to occur 2.8 times within 10 years and will be 1.2 °C warmer. With a rise of +2 °C by 2100, it will occur 5.6 times and be 2.6 °C warmer;
- a heat wave that in the pre-industrial climate would have occurred 1 time every 50 years is now expected to occur 4.8 times over 50 years and will be 1.2 °C warmer. With +2° C of global warming, it will occur 13.9 times and be 2.7 °C warmer.

It should be emphasized that these numbers refer to moderate heat waves. More extreme events may be up to a hundred times more likely due to climate change.

Chronic phenomena

Temperature

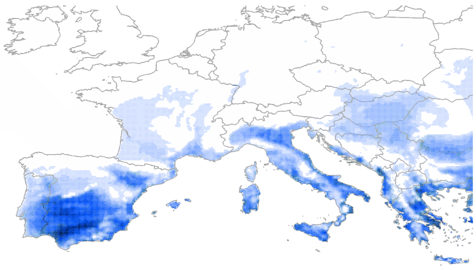
Chronic temperature changes can be analyzed to obtain information about the potential effects on the cooling and heating demand of local energy systems. The thermal requirement has been measured using Heating Degree Days (HDDs), i.e. the sum, for all days of the year with a $T_{average} \leq$ 15 °C, of the differences between the internal temperature (with $T_{internal}$ assumed to be 18 °C) and the average temperature, and Cooling Degree Days (CDDs), i.e. the sum, for all days of the year with $T_{average} \geq$ 24 °C, of the differences between $T_{average}$ and $T_{internal}$ (assumed to be 21 °C), respectively, for heating and cooling requirements. The country averages have been calculated as an average over the country, weighting each geographical node by population thanks to the use of the Shared Socioeconomic Pathways (SSPs) associated with each RCP scenario. Since CDD is the variable that experiences the greatest change, the figure shows CDDs at high resolution for the historical data and the average variation expected in the RCP 2.6 scenario in the 2030-2050 period for Europe and South America. The distribution of the population used as a weight for the calculation at the national level is also shown.

(32) The conclusions on the heat waves that occurred in the summer of 2023 were derived from analyses conducted by members of the scientific community using the experimental "ClimaMeter" framework. More information is available at the following link: https://www.climameter.org/home.

COOLING DEGREE DAYS (CDD)

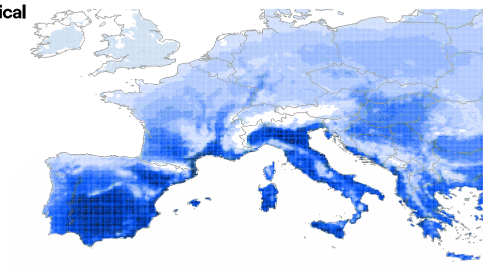
Degree days per year historical

- 0 • 100
- 100 • 200
- 200 • 300
- 300 • 400
- 400 • 500
- 500 • 600
- 600 • 700
- 700 • 781



Δ degrees/year – RCP 2.6 vs historical

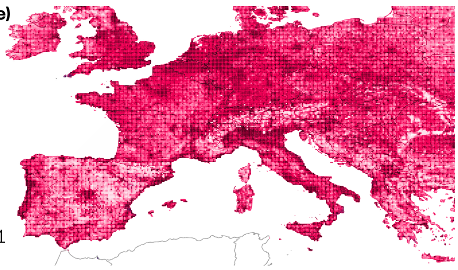
- 0 • 20
- 20 • 40
- 40 • 60
- 60 • 80
- 80 • 100
- 100 • 120



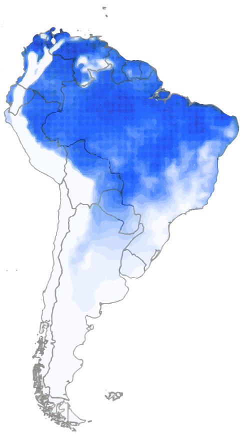
POPULATION DISTRIBUTION

Population (thousands of people)

- 0 • 22
- 22 • 289
- 289 • 995
- 995 • 2,599
- 2,599 • 7,320
- 7,320 • 2,715,581

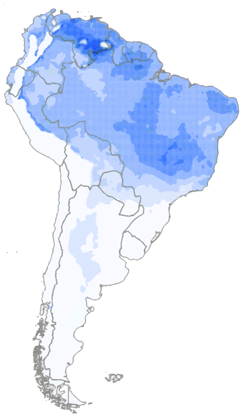


COOLING DEGREE DAYS (CDD)



Degree days per year historical

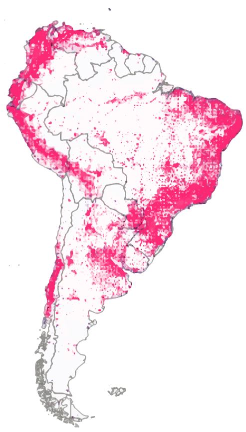
- 0 • 500
- 500 • 1,000
- 1,000 • 1,500
- 1,500 • 2,000
- 2,000 • 2,500
- 2,500 • 3,000
- 3,000 • 3,038



Δ degrees/year – RCP 2.6 vs historical

- -2 • 50
- 50 • 100
- 100 • 150
- 150 • 200
- 200 • 250
- 250 • 300
- 300 • 350
- 350 • 610

POPULATION DISTRIBUTION

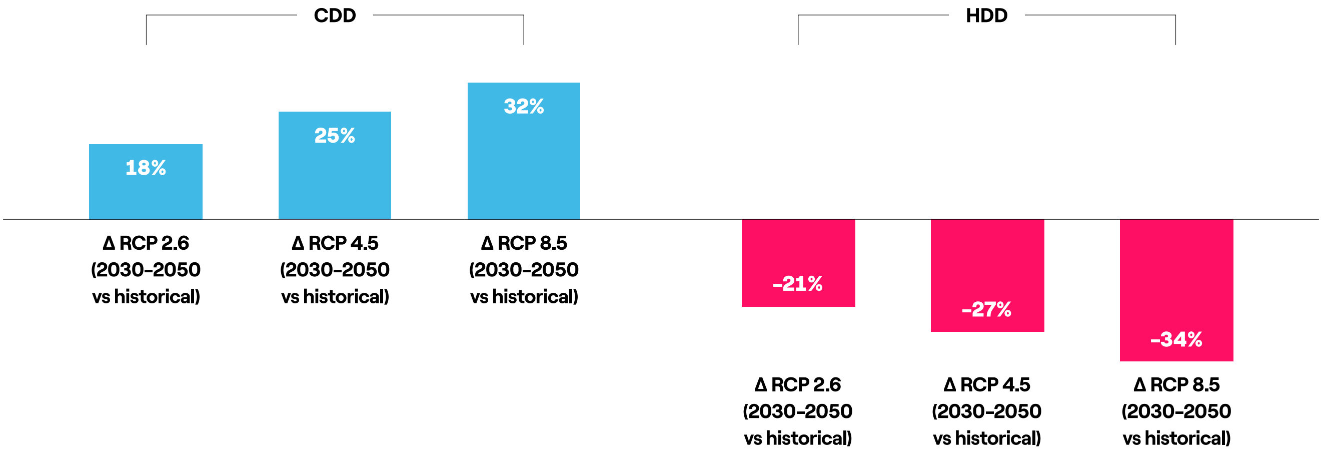


Population (thousands of people)

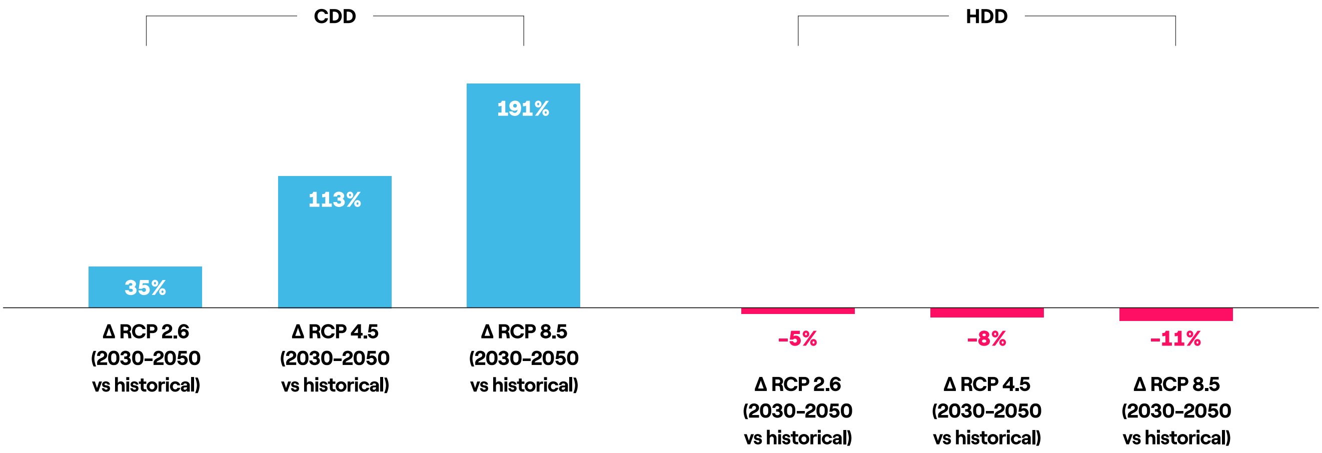
- 0 • 1.4
- 1.4 • 2.6
- 2.6 • 4.8
- 4.8 • 9.8
- 9.8 • 22.5
- 22.5 • 4,927.4

In general, in 2030-2050 CDDs show a rising trend, always exceeding the historical data, with increases in all the various scenarios. This agrees with the increase in average temperatures predicted by climate models, which is then also reflected in an increase in cooling needs. Heating requirements also decline as temperatures increase, although the rise is less pronounced than that in the cooling requirement. The table reports the country-level percentage changes for the countries of greatest interest to the Group under the RCP 2.6, RCP 4.5 and RCP 8.5 scenarios.

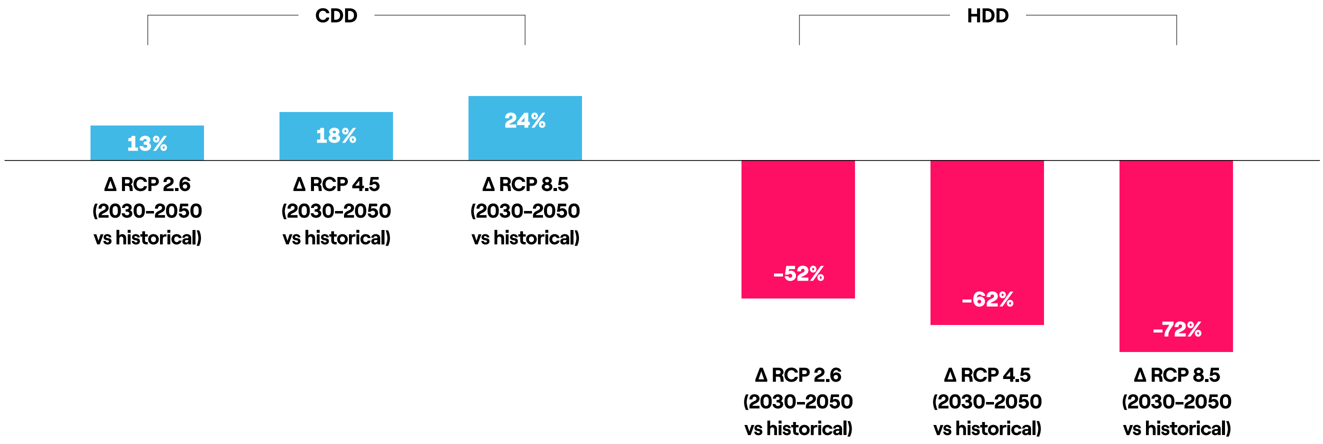
BRAZIL



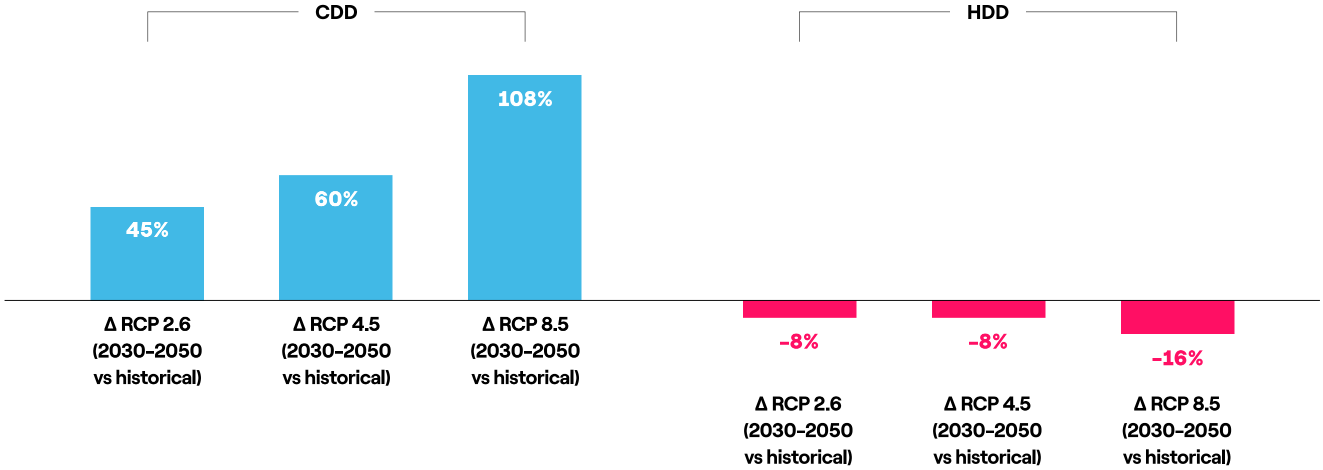
CHILE



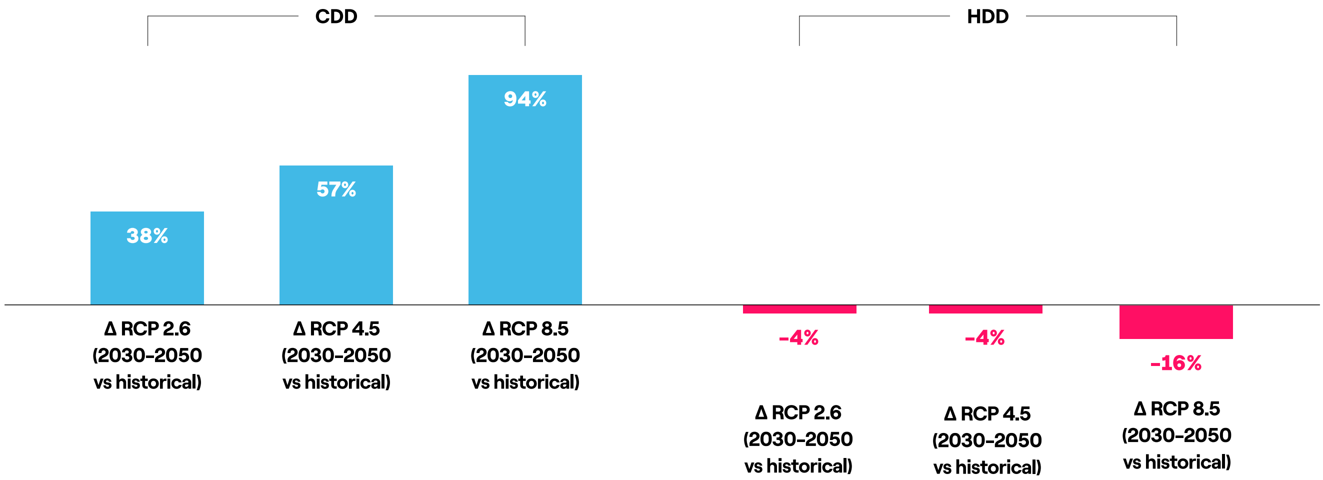
COLOMBIA



ITALY



SPAIN



Precipitation

Another chronic phenomenon of interest is the change in total precipitation due to climate change, which could impact hydroelectric generation. Changes in this phenomenon in the areas of interest for the Group have therefore been analyzed. The analysis of European catchment areas, which compared the 2030-2050 forecast with 1990-2020, points to no significant change, with a generalized slightly downward trend in central and southern Italy and Spain under the RCP 2.6 scenario.

As regards South America, the analyses, which compare the same time intervals, show a downward trend in Argentina and Colombia. Brazil is projected to experience a slight increase or decrease in total rainfall under the RCP 2.6 scenario depending on the group of catchment areas considered. Finally, as with Argentina and Colombia, the projections for Chile also point to a reduction in total rainfall in the scenario with the lowest emissions, but this may have already manifested itself in recent years (with a real decrease on historic norms).

Comparing the various RCPs (2030-2050) and the historical model (1990-2020), expected total annual rainfall tends to decline in Central America, while in North America it will remain the same or increase depending on the area.

Overall effect of the transition and physical scenarios on electricity demand

The use of integrated energy system models described in the section "Local transition scenarios" makes it possible to quantify the individual service demand of a country. This makes it possible to discriminate the specific long-term effects that a change in temperature can have on energy demand. For this purpose, the Reference, Slower Transition and Accelerated Transition scenarios described above have been expanded to include the effect that temperature increases have on energy demand (total, not just electricity) for residential and commercial heating and cooling, as measured in terms of Heating Degree Days (HDDs) and Cooling Degree Days (CDDs).

The definition of a benchmark scenario consistent with achieving the Paris objectives makes it possible to associate HDDs and CDDs consistent with the RCP 2.6 scenario to the Reference scenario and the Accelerated Transition scenario, which is characterized by a faster decline in emissions. HDDs and CDDs consistent with RCP 4.5 were instead associated with the Slower Transition scenario, because it corresponds to a slower decline in greenhouse gas emissions. To stress the analyses further, the latter scenario was also associated with RCP 8.5.

Italy and Spain

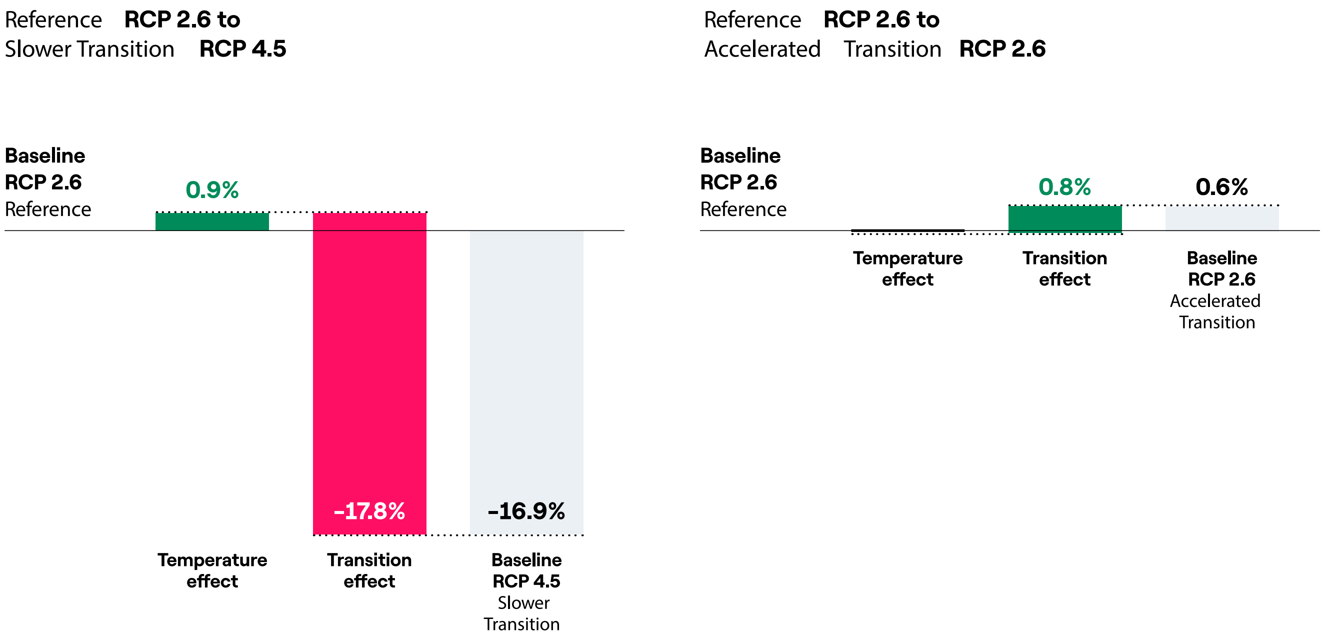
For Italy, the change in the level of electricity demand between the two extreme scenarios considered (Slower and Accelerated Transition) due to transition phenomena is about 18 percentage points on average in the 2031-2050 period. Excluding the effect of electricity demand for green hydrogen production, the difference in electricity demand falls to 8%.

As regards Spain, the percentage differences due to transition phenomena are smaller than in Italy, since the existing National Energy Plan sets particularly ambitious climate objectives. Consequently, less variability is expected in the evolution of the energy system and therefore electricity demand in the 2031-2050 period. The delta between the two extreme cases considered (Slower and Accelerated Transition) is around 10 percentage points on average in 2031-2050. If we exclude the effect of electricity demand for hydrogen production, the difference narrows to around 2%.

For both countries, the speed of the energy transition has a much greater impact on the level of electricity demand than the effects of the increase in temperature deriving from climate change, as the analyses performed show how the latter causes demand to increase by less than one percentage point for both Italy and Spain.

CLIMATE AND ENERGY TRANSITION SCENARIOS: IMPACT OF TEMPERATURE AND TRANSITION ON ELECTRICITY DEMAND

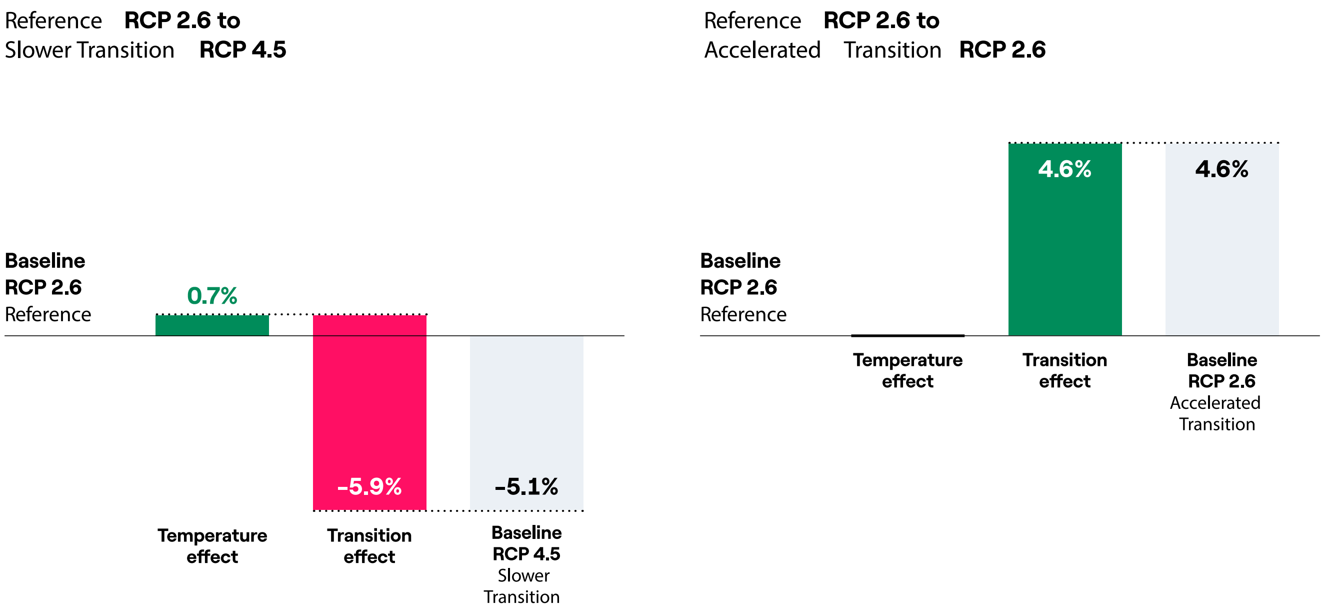
ITALY



Italy – Average impact on electricity demand (2031-2050) of the three transition scenarios coupled with the associated RCP 2.6 and 4.5 scenarios.

CLIMATE AND ENERGY TRANSITION SCENARIOS: IMPACT OF TEMPERATURE AND TRANSITION ON ELECTRICITY DEMAND

SPAIN



Spain – Average impact on electricity demand (2031-2050) of the three transition scenarios coupled with the associated RCP 2.6 and 4.5 scenarios.

In order to further investigate the effect of temperature on the transition scenarios and at the same time expand the range of assumptions regarding climate change, a sensitivity analysis was conducted by associating the Slower Transition scenario to RCP 8.5 in addition to RCP 4.5. The analysis found that on average the change in electricity demand due to a deterioration in the climate scenario in 2031-2050 was negligible.

Effect of temperature and transition on electricity demand, average over the specified period of temperature and transition contributions for different combinations of transition scenarios and climate pathways, with and without green hydrogen

		Reference **to** Slower Transition		**RCP 4.5**	Reference **to** Slower Transition		**RCP 8.5**	Reference **to** Accelerated Transition		
		Transition effect	**Temperature effect from RCP 2.6 to RCP 4.5**	**Total impact**	**Transition effect**	**Temperature effect from RCP 2.6 to RCP 8.5**	**Total impact**	**Transition effect**	**Temperature effect from RCP 2.6 to RCP 2.6**	**Total impact**
Italy	2024-2030	-4.0%	0.0%	-4.0%	-4.0%	0.0%	-4.0%	1.0%	0.0%	1.0%
	2031-2050	-17.8%	0.9%	-16.9%	-17.8%	0.9%	-16.9%	0.8%	-0.1%	0.6%
Italy without H2V	2024-2030	-3.1%	0.0%	-3.1%	-3.1%	0.0%	-3.1%	1.0%	0.0%	1.0%
	2031-2050	-7.9%	0.9%	-6.9%	-7.9%	0.9%	-7.0%	0.3%	-0.1%	0.2%
Spain	2024-2030	-4.2%	0.1%	-4.1%	-4.2%	0.1%	-4.0%	3.1%	0.1%	3.2%
	2031-2050	-5.9%	0.7%	-5.1%	-5.9%	0.7%	-5.2%	4.6%	0.0%	4.6%
Spain without H2V	2024-2030	-2.7%	0.0%	-2.7%	-2.7%	0.1%	-2.6%	2.2%	0.0%	2.2%
	2031-2050	-5.6%	0.8%	-4.8%	-5.6%	0.7%	-4.9%	2.2%	0.1%	2.3%

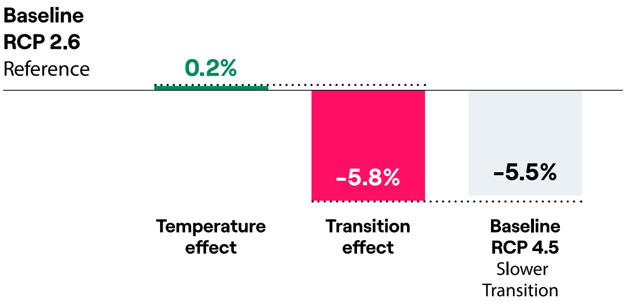
Note that in future years greater than expected electrification of heating in buildings could change both the sign and the size of the temperature effect in both countries. It is therefore necessary to monitor developments in the share of electrification of heating during the annual review.

Latin America

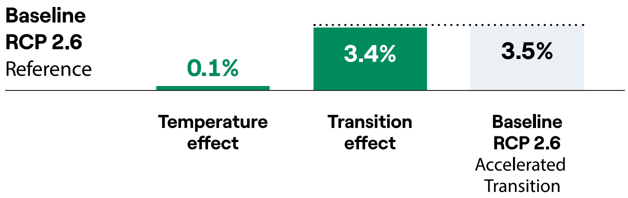
In Latin America, the impact of temperature trends, quantified through the Heating Degree Days (HDDs) and Cooling Degree Days (CDDs) metrics, was estimated using integrated energy system models for Brazil, Chile and Colombia, similar to the approach adopted for Italy and Spain, as discussed above. Econometric forecasting models based on historical elasticity were used for Argentina.

In the case of Brazil, the transition effect considered individually (i.e. excluding the impact of an increase in temperature), electricity demand in the Slower Transition scenario is approximately 6% lower on average in 2031-2050 compared with the Reference scenario, given the different levels of ambition of the two scenarios in both 2030 and 2050. In the Accelerated Transition scenario, the slightly higher ambition in the Reference scenario is achieved via faster electrification. Accordingly, the electricity demand delta in 2031-2050 averages around a positive 3-4%. Also in this case, the speed of the energy transition has a much greater impact on the level of electricity demand than the negligible effects of the increase in temperature deriving from climate change.

Reference **RCP 2.6 to**
Slower Transition **RCP 4.5**



Reference **RCP 2.6 to**
Accelerated Transition **RCP 2.6**



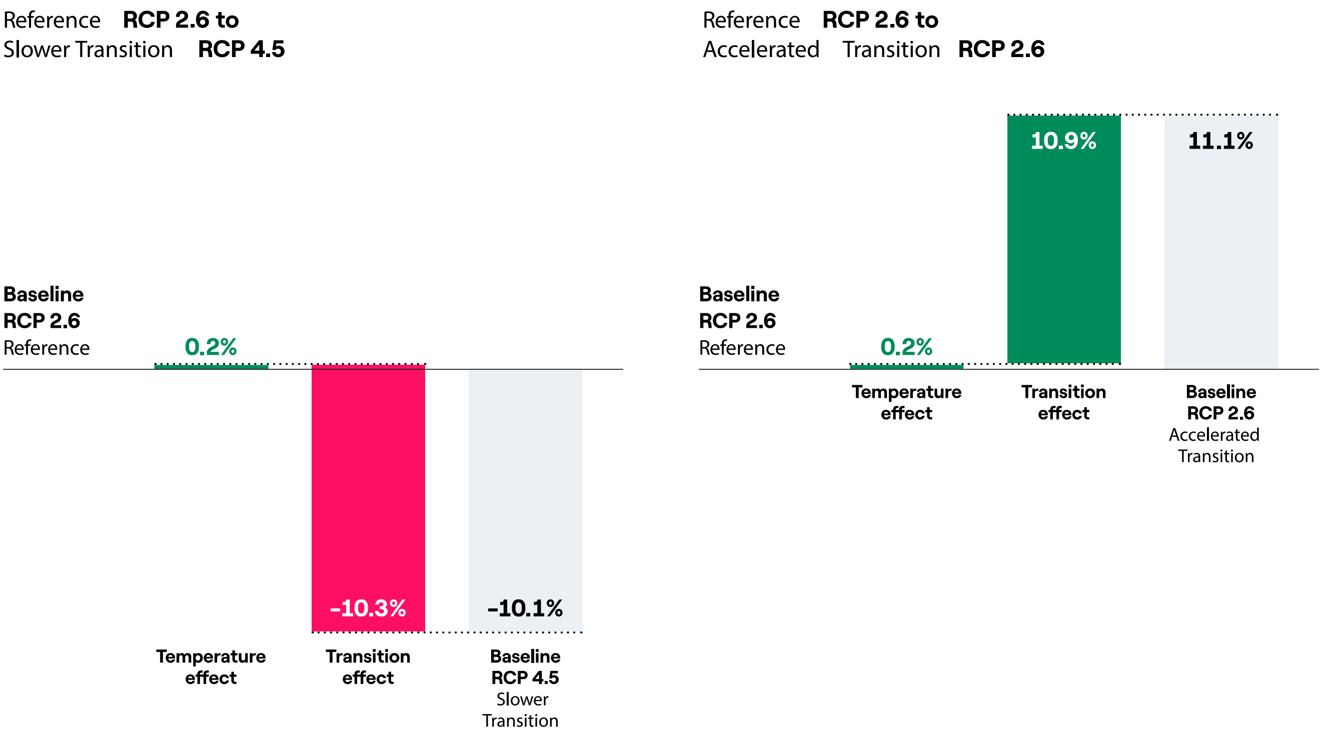
Brazil – Average impact on electricity demand (2031-2050) of the three transition scenarios coupled with the associated RCP 2.6 and 4.5 scenarios.

Here, too, a sensitivity analysis was carried out by associating the Slower Transition scenario with RCP 8.5 in addition to RCP 4.5. For Brazil, an assumption of a further temperature increase produces an increase in long-term demand of close to zero (2031-2050). The effect is not significant given that the delta in the CCDs for Brazil is one of the smallest among the countries analyzed.

Effect of temperature and transition on electricity demand, average over the specified period of temperature and transition contributions for different combinations of transition scenarios and climate pathways, with and without green hydrogen

		Reference **to** Slower Transition **RCP 4.5**			Reference **to** Slower Transition **RCP 8.5**			Reference **to** Accelerated Transition		
		Transition effect	**Temperature effect from RCP 2.6 to RCP 4.5**	**Total impact**	**Transition effect**	**Temperature effect from RCP 2.6 to RCP 8.5**	**Total impact**	**Transition effect**	**Temperature effect from RCP 2.6 to RCP 2.6**	**Total impact**
Brazil	2024-2030	-3.6%	0.1%	-3.5%	-3.6%	0.3%	-3.3%	1.1%	0.1%	1.2%
	2031-2050	-5.8%	0.2%	-5.5%	-5.8%	-0.2%	-5.9%	3.4%	0.1%	3.5%
Brazil without H2V	2024-2030	-3.5%	0.1%	-3.3%	-3.5%	0.3%	-3.2%	0.2%	0.1%	0.3%
	2031-2050	-6.2%	0.2%	-6.0%	-6.2%	-0.2%	-6.4%	3.4%	0.1%	3.5%

For Chile, electricity demand is reduced by transition effects considered individually by about 10% on average in 2031-2050 in the Slower Transition scenario compared with the Reference scenario, given the different levels of ambition of the two scenarios. This difference is mainly due to assumptions regarding the achievement of the country's ambitious targets for green hydrogen production after 2030 set out in the document *Planificación Energética Nacional de Largo Plazo* (PELP). If the effect of electricity demand for hydrogen production – for which the two scenarios have different levels of ambition in relation to the different decarbonization trajectories – is omitted, the difference declines to about 6%. In the Accelerated Transition scenario, the greater ambition of the energy transition is achieved through the implementation of more stringent decarbonization policies to achieve greater electrification, greater penetration of green hydrogen in industry and transport and increased exports of that hydrogen. This leads to an average increase of about 11% in electricity demand over the baseline of the Reference scenario in 2031-2050. Excluding the effect of electricity demand connected with the production of green hydrogen, electricity demand is an average of about 12% higher than in the Reference scenario in the 2031-2050 period. Once again, the speed of the energy transition has a much greater impact on the level of electricity demand than the increase in temperature caused by climate change.



Chile – Average impact on electricity demand (2031-2050) of the three transition scenarios coupled with the associated RCP 2.6 and 4.5 scenarios.

To stress the analyses further, the Slower Transition scenario was also associated with RCP 8.5. For Chile, an assumption of that further temperature increase produces an increase in long-term demand of close to zero (2031-2050).

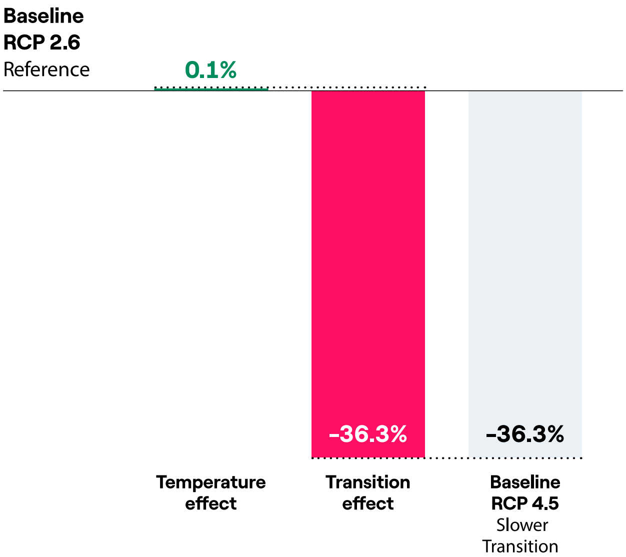
Effect of temperature and transition on electricity demand, average over the specified period of temperature and transition contributions for different combinations of transition scenarios and climate pathways, with and without green hydrogen

		Reference **to** Slower Transition **RCP 4.5**			Reference **to** Slower Transition **RCP 8.5**			Reference **to** Accelerated Transition		
		Transition effect	**Temperature effect from RCP 2.6 to RCP 4.5**	**Total impact**	**Transition effect**	**Temperature effect from RCP 2.6 to RCP 8.5**	**Total impact**	**Transition effect**	**Temperature effect from RCP 2.6 to RCP 2.6**	**Total impact**
Chile	2024-2030 2031-2050	-1.5% -10.3%	0.2% 0.2%	-1.3% -10.1%	-1.5% -10.3%	0.2% 0.3%	-1.2% -10.0%	1.5% 10.9%	0.1% 0.2%	1.6% 11.1%
Chile without H2V	2024-2030 2031-2050	-0.5% -6.2%	0.4% 0.4%	-0.2% -5.8%	-0.5% -6.2%	0.5% 0.5%	0.0% -5.7%	2.7% 11.5%	0.2% 0.5%	2.9% 12.0%

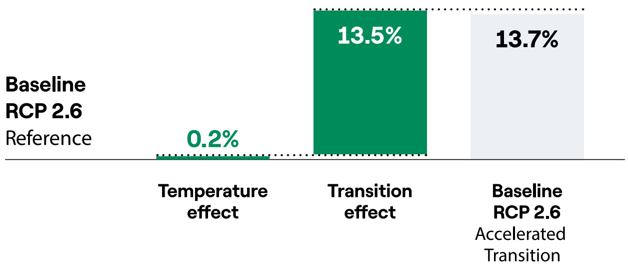
In the case of Colombia, transition effects reduce electricity demand in the Slower Transition scenario by about 36% in the period 2031-2050 compared with the Reference scenario, mainly reflecting the significant difference in the ambition of the two scenarios. The Slower Transition was defined by taking as a starting point the most prudent scenario in the national government plan (Hoja de Ruta de la Transición Energética Justa), characterized by limited decarbonization, which therefore leads to a much lower level of electrification than in the Reference scenario. On the other hand, the difference between the Reference scenario and the Accelerated Transition scenario shows an increase of about 14% due to the transition alone, while the climate effect is less than 1%. This reflects the increase in electrification resulting from much more ambitious decarbonization goals. The effect of hydrogen is not particularly relevant in the scenarios analyzed.

COLOMBIA

Reference Slower Transition **RCP 2.6 to RCP 4.5**



Reference Accelerated Transition **RCP 2.6 to RCP 2.6**



Colombia – Average impact on electricity demand (2031-2050) of the three transition scenarios coupled with the associated RCP 2.6 and 4.5 scenarios.

Effect of temperature and transition on electricity demand, average over the specified period of temperature and transition contributions for different combinations of transition scenarios and climate pathways, with and without green hydrogen

		Reference **to** Slower Transition **RCP 4.5**			Reference **to** Slower Transition **RCP 8.5**			Reference **to** Accelerated Transition		
		Transition effect	**Temperature effect from RCP 2.6 to RCP 4.5**	**Total impact**	**Transition effect**	**Temperature effect from RCP 2.6 to RCP 8.5**	**Total impact**	**Transition effect**	**Temperature effect from RCP 2.6 to RCP 2.6**	**Total impact**
Colombia	2024-2030	-2.3%	0.2%	-2.0%	-2.3%	0.2%	-2.1%	1.7%	0.1%	1.8%
	2031-2050	-36.3%	0.1%	-36.3%	-36.3%	0.1%	-36.3%	13.5%	0.2%	13.7%
Colombia without H2V	2024-2030	-2.2%	0.2%	-2.0%	-2.2%	0.2%	-2.0%	1.7%	0.1%	1.7%
	2031-2050	-36.2%	0.0%	-36.1%	-36.2%	0.0%	-36.1%	14.7%	0.2%	14.9%

Finally, as regards Argentina, the analyses performed show that an increase in temperature could increase electricity demand by between 0.4% and 0.8% (calculated as the average of demand forecasts for the 2031-2050 period). This estimate is highly dependent on the effect that macroeconomic conditions in the country might have on electricity demand. As a result, it is affected by a significant degree of uncertainty given the high volatility of the performance of the Argentine economy.